AMERICAN MACHINIST

A JOURNAL FOR MACHINISTS, ENGINEERS, FOUNDERS, BOILER MAKERS, PATTERN MAKERS AND BLACKSMITHS.

VOL. 16, NO. 47. WEEKLY. | NEW YORK, THURSDAY, NOVEMBER 23, 1893. | $3.00 per Annum. SINGLE COPIES 6 CENTS.

COPYRIGHT 1893, BY AMERICAN MACHINIST PUBLISHING COMPANY. For Sale Everywhere by Newsdealers. ENTERED AT POST OFFICE, NEW YORK, AS SECOND CLASS MATTER.

Some Notes on Indicator Reducing Gear.

By M. E.

Having aroused some small amount of interest in this subject by a former contribution, it has occurred to me that some brief general notes on the more ordinary forms of indicator reducing gear, might form a not altogether unacceptable sequel thereto. Possibly many who have not the time or inclination to follow a mathematical investigation of the various devices commonly employed, will nevertheless take some interest in the simple notes and comments here given.

The reducing arrangements referred to in the present instance are all of the vibrating lever type and are shown in the sketches with the cord attached to a pin or eye; the effect of substituting a "Brumbo pulley" for this method is noted in each case in which the alternative arrangement is permissible, and right here it may be noted that as a general rule, the Brumbo should only be used on a pendulum lever or its equivalent, swinging about a fixed center—the center of curvature of the arc of the Brumbo. Further it may be noted that the Brumbo can only give absolutely correct results when the lever is so driven that it receives equal *angular* movements for equal *linear* movements of the engine crosshead. This condition is not fulfilled by any of the devices here shown, and is in fact a requirement not to be met by any simple arrangement of pendulum lever unless the "reducing segment" may be so considered. But at the same time it will be seen that an approximation to this condition may be readily obtained by simple gears, and it follows that the Brumbo may frequently give better results than the pin cord connection. The point is to discern which method is the best to employ with different gears, and this after all is not a very difficult matter to decide if regarded from a practical and common-sense standpoint.

One of the commonest forms of pendulum reducing gear is that indicated in Fig 1, and which consists of a lever swinging about a fixed center C and provided with a pin P on which the cord is looped; the lower end of the lever is either forked or formed with a long slot as shown, in which engages the pin A fixed in or to the crosshead in any convenient manner. The briefest consideration will show that this combination cannot possibly give accurate results. For when the lever is passing the vertical the reduction of motion is represented by the ratio $\frac{C\ P}{C\ A'}$. At the extreme position shown (and assuming the cord to remain horizontal) the ratio is now that existing between the effective lengths of the lever, viz., $\frac{C\ B}{C\ A'}$, and as $C\ B$ is less than $C\ P$ it follows that the movement given to the cord is less towards the ends of the stroke than it should be, or that the drum motion gradually becomes slower as the lever approaches the limits of its travel in either direction.

In the arrangement under notice the effective length of the lever $C\ A$ is always constant and $= C\ A'$. It follows that by substituting the "Brumbo" for the "pin" cord connection, the reduction will be made much more nearly perfect, since in this way the effective length of the short arm of the lever ($C\ P$) is also made constant. At first sight indeed it might be supposed that an absolutely accurate gear could thus be made, but a careful examination will show that although considerably improved results are obtained, the drum motion is still slow at the ends of the stroke. That this is so may be readily seen by drawing lines representing the pendulum lever in successive positions as $C\ 2$, $C\ 3$, etc., corresponding to successive equi distant positions of the crosshead. Then it is clear that the arcs $P'\ 4'$, $4'\ 3'$, $3'\ 2'$ and $2'\ P$ are of gradually decreasing length and consequently the amount of cord wrapped round the segment is not proportional to the uniform travel of the crosshead. In other words this pin and slot method of driving the pendulum lever does not give to the latter an equal angular movement for an equal linear movement of the crosshead and the full value of the Brumbo cannot therefore be obtained.

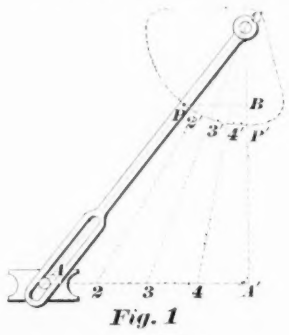


Fig. 1

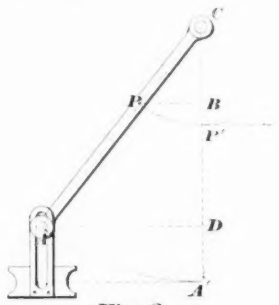


Fig. 2

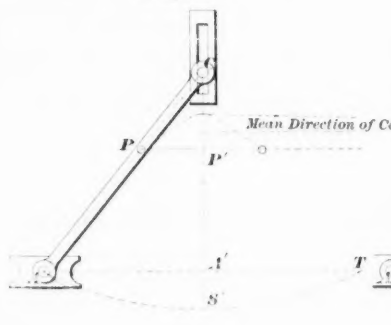


Fig. 3

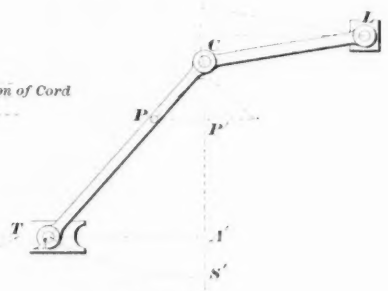


Fig. 4

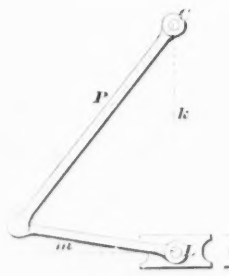


Fig. 5

Fig. 6

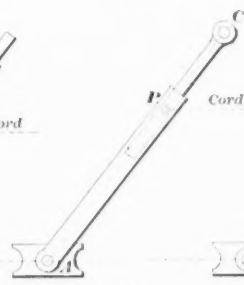


Fig. 7

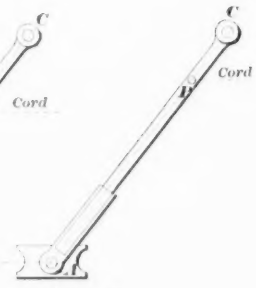


Fig. 8

American Machinist

INDICATOR REDUCING GEAR.

Very much better results are given by the device shown in Fig. 2, provided a "pin" cord connection is used. Here the pendulum lever carries a pin at its lower extremity, which engages with a vertical slot in a plate or equivalent device attached to the crosshead. When the lever is vertical the reduction is $\frac{C\ P}{C\ A'}$, while in the extreme position shown it is $\frac{C\ B}{C\ D}$. But it is clear that $\frac{C\ P}{C\ A'} = \frac{C\ B}{C\ D}$, and as this will be true for any position of the lever, the reduction is seen to be quite accurate if we neglect the slight vertical movement of the cord from P' to B which does not perceptibly affect the result. As the effective length of the lever varies throughout the movement, the effect of using a Brumbo in place of the pin P—thus making the short arm of the lever $C\ P$ constant—will be to render the reduction inaccurate by causing the drum movement to be considerably in excess of that required, as the ends of the stroke are approached. This is a serious error which is frequently committed with the mistaken idea of improving the reducing gear.

The rig shown in Fig. 3 gives good results although it is not often used. Here the lower end of the lever turns about a pin fixed in the crosshead, while another pin in the upper extremity of the lever plays up and down in a fixed vertical slot-way as indicated. It is clear that for all positions of the lever the *ratio* of the reduction is $\frac{C\ P}{C\ A'}$ and therefore the only error possible is that due to the rise and fall of the pin P to which the drum cord is attached. It will be noticed that this effect is much greater than in the previous case, the vertical movement of P being now equal to the *versed sine* $A'\ S$ of the arc $A\ S\ T$. But unless the lever is very short and the indicator placed close to the reducing gear the error due to this cause is negligible. In fitting up this gear great care should be taken to insure the slot-way being perfectly at right angles to the path of the crosshead.

The desire to avoid the use of slots and pins has led to the adoption of the modified form of this gear shown in Fig. 4. The lever $C\ L$ should not be less than half the length of the main lever, and the fixed center L should be so located that $C\ L$ is as much below the horizontal at the extremities of the stroke that it is above it at mid-stroke. It is evident that this last arrangement though of a more mechanical design may give less accurate results than the preceding one, since C moves in an arc instead of in a straight line. The distortion due to this cause (which will not be great if the foregoing points are observed) will be partially counteracted by the rise and fall of the pin P, provided the lever $C\ L$ lies in the same direction as the cord is taken. But if $C\ L$ is placed on the other side of the vertical, the sum, instead of the difference, of these errors will influence the motion of the drum, the displacement of the latter from its true position being greatest at the two extremities and at the center of the stroke. The Brumbo pulley is not admissible in this case.

The rig shown in Fig. 5 is very extensively employed, but unless carefully arranged it gives most incorrect results. It may be regarded as a modification of Fig. 2, the equivalent of an infinitely long connecting rod which is there found, being in this case replaced by one of finite length. It follows, therefore, that the link $A\ L$ should be of ample length if the distortion due to its vibration is to be reduced to a negligible amount. Also the center C should be so chosen that the link $A\ L$ vibrates equally above and below the horizontal as noted in connection with Fig. 4.

Since the error with this gear is due to angular movement of the connecting link it will be seen that the motion of the drum will be too fast at that end of the stroke at which the link is placed, while it will be too slow at the other end of the stroke. With the Brumbo pulley in place of the pin connection for the cord the error is similar in character but somewhat more pronounced.

I have before now been much surprised to find engine builders of repute using a reducing gear of this kind with a connecting link less than one-fourth of the length of the pendulum lever. With such proportions the cards must of necessity be very inaccurate, misleading those who endeavor to reason out the various events in the steam and exhaust strokes and introducing errors in the calculations of the mean effective pressure. With regard to the last-named point it is frequently asserted that when cards are taken from both ends of the cylinder, the errors compensate each other. Obviously this can only be perfectly true when exactly similar cards are obtained from each end, but these frequently differ materially, and the best that can be said regarding this contention is that it is a very lame excuse for a very bad practice.

Before leaving this rig I might point out that by the addition of two links $m\ k$ and $P\ k$ ($m\ k$ being parallel and equal to $P\ A$) the motion may be made to give absolutely correct results, the cord being attached to the point k. This forms a very simple pantagraph reducing gear which deserves to be more generally employed. Of course the length of $P\ k$ must be such that C, k and L lie in one straight line.

The desire to employ more mechanical ar-

rangements in place of pin and slot gears has led to the use of various forms of telescopic devices such as are represented in Figs. 6, 7 and 8. In the first of these the cord is attached to the lower end of a tube turning about a fixed center or trunnion *C*. The pendulum takes the form of a round rod connected to the crosshead by the pin *A*. It will be readily seen that while the vertical length of the lever *C P* increases as mid-stroke is approached, that of *P A* simultaneously decreases. The arrangement is therefore as radically bad as that shown in Fig. 1, of which, indeed, it is only a disguised form.

The telescopic gear shown in Fig. 7 is seldom used, fortunately, for a more inaccurate rig cannot well be devised. In this case the cord is attached to the upper end of the tube, the lower end being pin connected to the crosshead as indicated. It will be readily perceived that the virtual length of *P A* is increased as mid-stroke is approached while at the same time *C P* is diminished. The error due to the vertical movement of the cord is also as great as in Fig. 3, so that, altogether, the use of this rig cannot be too strongly condemned. The rig shown in Fig. 8 will be seen to be exactly similar in principle to Fig. 6, and the same remarks apply.

No mention has been made of the various reducing wheel methods of actuating the paper drum, nor of the pantagraph and laytong devices by which most satisfactory results are to be obtained. The endeavor has rather been to point out a few of the shortcomings of pendulum reducing gear and to indicate which arrangements and combinations give the best results. Some of the points raised may appear of a somewhat trivial character, but it must be borne in mind that too much care cannot be exercised in indicator practice. Certainly the use of faulty reducing gear is a poor compliment to the ingenuity and skill which modern instrument makers bestow upon the high-class steam engine indicators which are now available.

latter is subjected to destructive strains in addition to those legitimately brought upon it, but two strong channel bars upon which the machinery, including the boiler, and engine rests, so that none of the working strains are transmitted through the boiler, the latter resting on the channel bars as free to expand and contract as if it were fifty feet away. In other words, nothing is required of the boiler except to furnish steam, which is all it should be required to do, in the interest of safety and reasonably long life.

As is well known, traction engines are subjected to hard shocks on uneven ground, with corresponding tendency towards the destruction of the gearing. To modify this an elastic compensating gear is employed, the springs yielding to what would otherwise be destructive strains, and giving smooth action.

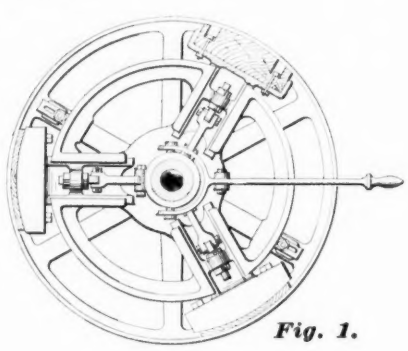
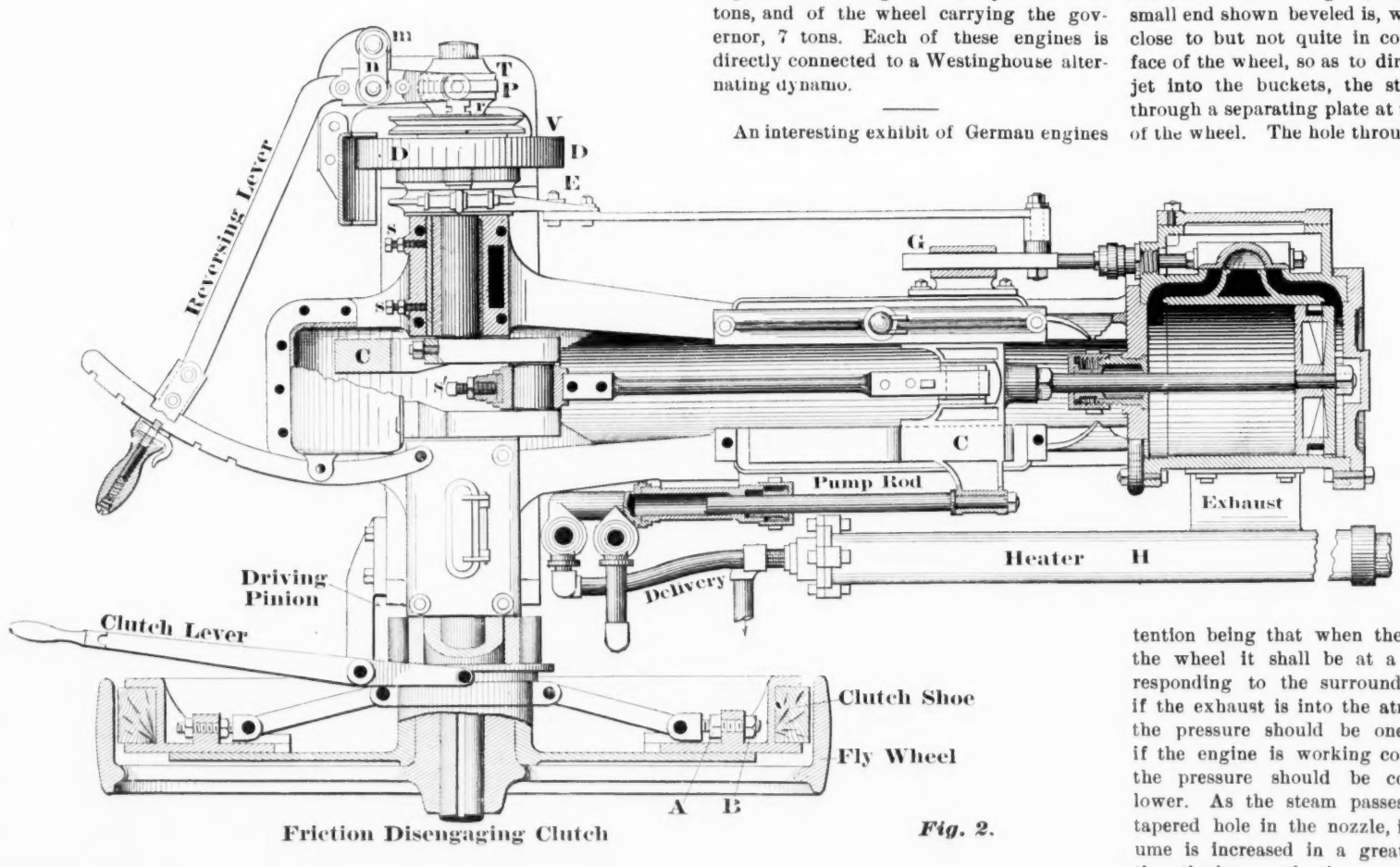


Fig. 1.



Friction Disengaging Clutch

Fig. 2.

Another feature that has been recently added to these engines is a friction clutch; this clutch is shown in Fig. 1, and as applied to the engine in the plan, Fig. 2. By the use of this clutch the engine can be engaged with and disengaged from the traction gearing without shock or jar, and with the engine running at full speed. This means of easy and rapid disconnection and connection is a valuable feature in case of an emergency, and also in getting the engine in position for the belt, as in threshing. Also in case an obstruction is met with, in which case the friction is thrown out, the engine got up to full speed and the friction thrown in, thus utilizing the momentum and full speed of the engine in overcoming the obstacle. In case of an extraordinary shock, the clutch will yield, thereby avoiding breakage. This friction clutch can be applied to the Frick traction engines built previous to its adoption.

Six of the engines of the Westinghouse Machine Co., of Pittsburgh, Pa., represent a radical departure from the usual practice of that company, in that they are double-acting instead of single-acting. The vertical section, page 3, will give an idea of the construction. As will be seen, these engines are compound. The high-pressure cylinders are 21½ inches diameter, and the low-pressure 37 inches, with stroke of pistons 22 inches. The speed is 200 revolutions. The valves of the high-pressure cylinders are of the piston type, and those of the low-pressure are flat slides. These flat slides are relieved of excessive pressure against the seat by the introduction of steam of boiler pressure into a recess in the center of the face of the valve. The valve of each cylinder is operated by a separate eccentric, that of the low-pressure being fixed, and that of the high-pressure under control of the governor.

The valve motion of the high-pressure cylinder is connected with an air piston shown in the engraving. This piston moves in a closed cylinder in such a way as to compress the air during the stroke of the valve in either direction, thus helping to arrest the motion of the valve, and to start it in the opposite direction. In starting the engine the valve motion is disconnected from the eccentric, and the high-pressure valve worked by admitting and releasing steam alternately from each end of the air cylinder.

The main bearings are 14 inches diameter, and 30 inches in length. The floor space is 11x15 feet, and the height above the floor 17½ feet. The weight of the fly-wheel is 12 tons, and of the wheel carrying the governor, 7 tons. Each of these engines is directly connected to a Westinghouse alternating dynamo.

An interesting exhibit of German engines is made by R. Wolf, of Magdeburg-Buckau This exhibit is in the line of portable and semi-portable engines. The largest of these is a semi portable compound, with cylinders (about) 10¼ and 17 inches diameter, and a stroke of 15¾ inches. The cylinders, receiver and dome of the boiler are cast in one piece. The sketch, Fig. 3, page 3, will give an idea of this. No fault can be found with the mechanical arrangement. If it is a good thing to jacket the cylinders and receiver to the extent shown, then the job is well done.

"Rider" expansion valves are employed, that of the high-pressure cylinder being controlled by a governor of the "Porter" type, while that of the low-pressure cylinder is adjustable by hand.

The air pump is driven by an eccentric on the outer end of the crank-shaft, the feed pump plunger being attached to a cross tail. The main journals are both in a single saddle piece.

The boiler is what is termed by the manufacturer the "extractible tube" boiler which I believe is the construction of all fire-box boilers built by Wolf. That is, by breaking two joints the fire-box with the tubes intact can be removed for cleaning or repairs. Fig. 4 will show how this is accomplished, the sketch showing the boiler as when the tubes are being removed. Fig. 5 is a reproduction of a sketch showing that the tubes are so located that all parts of them can be come at for scaling, with a suitably shaped chisel.

This engine is as elaborate in its appointments as a fixed engine, and in every respect is a beautifully finished product.

Of the other engines, one is a single cylinder non-condensing, with automatic cut-off, and the other a portable, with cut-off adjustable by hand. They are all by far the best finished and most complete engines of their type that I have ever seen.

An extremely interesting exhibit is that of steam turbines made by Dr. Gustaf De Laval, of Stockholm, Sweden. The turbine in these machines is a small steel disk, in which buckets are milled and then closed on the circumference by shrinking on a steel band. This turbine is mounted on a horizontal shaft, and the steam is directed into the buckets through small nozzles at a slight angle to the plane of the wheel, that is, at nearly right angles to the axis. Fig. 6 represents the turbine, shaft and driving pinions, in this case there being two pinions gearing into separate wheels, one at each side. Fig. 7 represents the nozzle, not to the same scale as Fig. 6; the part at the small end shown beveled is, when in place, close to but not quite in contact with the face of the wheel, so as to direct the steam jet into the buckets, the steam escaping through a separating plate at the other face of the wheel. The hole through this nozzle is tapering, being largest at the discharge end, and it is in this nozzle that the benefit of expansion is obtained. Passing through this tapering hole the steam is expanded—increased in volume—the intention being that when the steam strikes the wheel it shall be at a pressure corresponding to the surroundings, that is, if the exhaust is into the atmosphere then the pressure should be one atmosphere; if the engine is working condensing then the pressure should be correspondingly lower. As the steam passes through the tapered hole in the nozzle, its specific volume is increased in a greater proportion than the increase in the cross-section of the hole, or passage way, which causes an increased velocity, thus converting its capacity for work into momentum, which is utilized in the turbine, the speed of the latter being limited by considerations of safety only. As for example, one of the engines exhibited—a 20 horse-power—driving a dynamo runs at 22,000 revolutions, smaller sizes making 30,000, or more, revolutions.

At such high speed it has been found impossible to make the turbine homogeneous enough in structure to run in perfect balance; to overcome this difficulty, which at such speed is formidable, the shaft is made so small as to be flexible, permitting the turbine at its high velocity to revolve, practically, around its center of gravity, the axis of the shaft describing a surface of revolution, the box at the free end being of the ball pattern.

The speed is reduced to that desired by gearing, the teeth being spiral, as shown in Fig. 6, very small, and at an angle of about 45 degrees.

Notes from the Fair.

Editorial Correspondence.

Frick Company, Waynesboro, Pa., exhibit what is termed an 11-ton refrigerating machine, the construction of which has been made familiar to our readers. It is a finely constructed machine, illustrating the perfection to which this class of machinery has been brought.

This company have also here one of their portable engines and one of their rather famous "Eclipse" traction engines. This machine is a traction engine from the bottom up, and not a mere adaptation of traction to a portable engine, which is quite a different thing. The foundation—so to speak—is not the boiler, in which case the

These turbines run still, and apparently without trouble from heating, and, of course, occupy but very small space. They are made in various sizes, and are said to work with an economy equal to that of triple expansion engines of corresponding power.

The Robb Engineering Co, Amherst, N. S., have in the Canadian department, Machinery Hall, a very good example of the Robb Armstrong automatic engine. This engine was illustrated and described in our issue of April 21, 1892, to which issue our readers are referred for particulars.

Percy Simundt, of Berlin, shows some grate bars for steam boilers, the chief characteristics of which are very small air space fantastically cut up, and the metal of which they are made, which is termed "tempered steel." The names applied to different varieties of these bars, such as "polygonal," "arrow," and "serpent" designate more or less clearly the forms of air openings. It is claimed for these bars that clinkers will not adhere to them, and that they will last several times as long as ordinary cast-iron bars. Ed. Werthein is Mr. Simundt's agent, at 403 Omaha Building, Chicago.

Another grate bar is shown by Caddy & Co., Limited, of Daybrook, Nottingham, England; this is called a "smoke consuming" bar. It is a hollow bar, the hollow or tubular feature being obtained by casting the bar around a wrought iron tube. A section, about half size, of one of these bars is shown in Fig. 8. Through this tube air passes to the combustion chamber behind the bridge wall, being heated in its passage and, of course, keeping the temperature of the upper surface of the bar somewhat lower than it would otherwise be.

The upper surface of the bar is chilled,

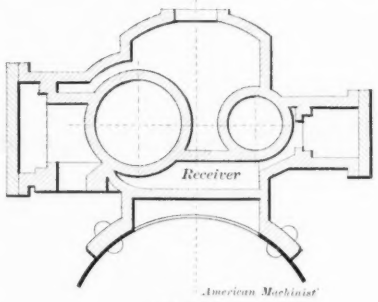


Fig. 3.

the closely-hatched part of the sketch showing the extent of the chilling. This bar, it is said, will not clinker nor warp. As an evidence of its lasting qualities bars are shown that have been in constant use for about seven years, and they certainly do not look much the worse for their service.

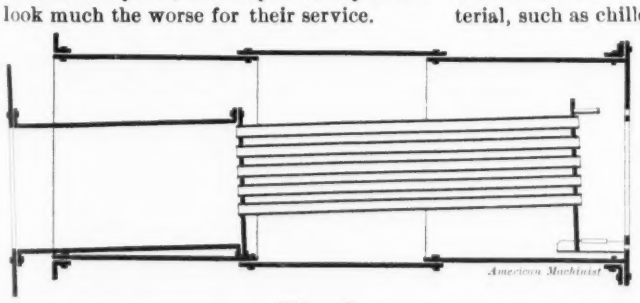


Fig. 4.

Smokeless furnaces are said to result from the use of this bar, as well as a saving in coal. The principle of smoke prevention involved in its use seems to show that the state of the art in avoiding the nuisance of smoke is about the same in England as here, but here fuel saving and smoke prevention have not been found together. The bars are, of course, made differently for different purposes, Fig. 9 representing the arrangement for a Lancashire boiler.

For a hollow bar this is the best I have ever seen, the chilled surface being undoubtedly a good feature as well as the plan for making the bar hollow.

The bars mentioned as well as another bar of German make are deficient in air space judged by American practice, but perhaps American practice is in the direction of giving more room for air than is advisable. The English bar comes nearest to practice here in that respect. H.

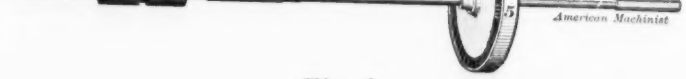


Fig. 6.

Fig. 7.

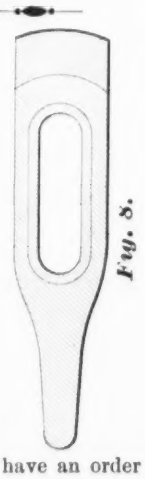
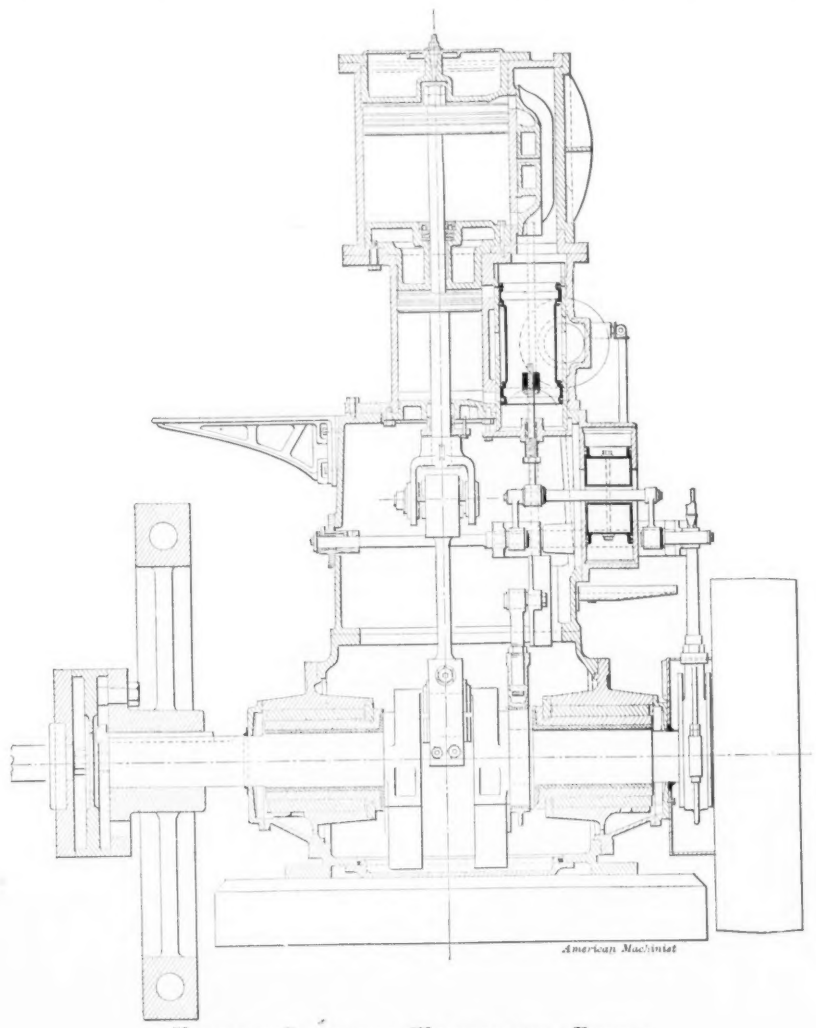


Fig. 8.

D. M. J. Gessner, 5 Passage Priver (Faubourg du Temple), Paris, writes us: I have an order in hand for the complete outfit of a sewing machine factory. Will you kindly ask manufacturers of special machines for manufacturing sewing machines to correspond with me and send catalogues?

Annual Report of the Chief of the Bureau of Steam Engineering.

Commodore Melville's report this year is a very interesting document, comparatively brief, and very much to the point. It gives



VERTICAL SECTION OF WESTINGHOUSE ENGINE.

the general operations of the Bureau in the designing of machinery, and in other matters.

Of the Navy Yard shops he has this to say in regard to what has come to be a serious defect:

Attention has frequently been called to the greatest defect in most of the shops of this Bureau, viz., the want of appliances for handling heavy weights. In many of the older buildings this cannot be altogether rectified, as they were constructed with one or two rows of columns extending down the center, making the use of overhead traveling cranes impossible, and necessitating the employment of pillar and locomotive cranes and trucks.

In this respect these shops are in the same condition as many shops of manufacturing concerns in the country that were built before the modern traveling crane was perfected, and hence without provisions for its use. The only remedy here in many cases is new construction, and this applies equally to Navy Yard shops.

The work done at the different yards during the past year is referred to, and the present condition of the machinery of naval vessels and the work required is given in detail, as well as the condition of work under construction.

Under "Contract Trials of New Vessels," the pertinent data pertaining to the trials of the "Monterey," "Bancroft," "Detroit," "New York," and "Machias" are tabulated. The coal consumption under forced draught of the "Bancroft" was 2 53 pounds per indicated horse power per hour. The quality of the coal is said to have been "excellent." With the "Machias" 2 44 pounds of hand-picked coal were required. The engines and auxiliaries of the first named vessel indicated 1 270 46 horse power, and of the last, 1,963 40. At the dock trial of the "Maine" the coal consumption was slightly less than two pounds per indicated horse-power per hour.

This about boilers in the navy is worth quoting:

It may not be out of place to recall the fact that when, a few years ago, foreign governments were reducing the weight of machinery in their ships, a favorite method, and the one which effected the greatest reduction, was to reduce the size of the boiler, making the gases from the several furnaces (as many as eight in large double ended boilers) debouch into a common combustion chamber, and by using very strong forced draught get an indicated horse power on trial, which so weakened the boilers, and produced so much leakage around the tubes, as to make the boilers almost worthless before beginning service. This type of boiler is one which this Bureau has constantly opposed as being unfit for naval vessels, and unsuited to the purposes of forced draught. The type adopted by the Bureau is one which long experience had shown to be efficient and capable of withstanding hard usage, and it is a source of great satisfaction to know that in the trials of our new ships the boilers have stood the strain admirably, and that in service they have proved highly satisfactory. To such an extent had the former design been carried in England, with attendant leakage and unreliability of the boilers, that it was deemed necessary to appoint a committee of engineers to "consider existing types and designs of propelling machinery and boilers," and to make suggestions for their improvement.

The report of this committee, recently published, recommends a type of boiler almost identical with that which this Bureau has been designing. The committee likewise recommends certain apparatus connected with the feeding and the circulation of water in the boilers which has always been required in our machinery specifications. I deem this statement of the trials of our foreign brethren justified, in view of the statements which were so loudly expressed at one time, that our machinery was too heavy, that we were putting 30 per cent more weight in our boilers than were the English, and similar statements calculated to discredit the work of this Bureau. In the light of the sad experience which that type of boiler has had, it looks as if we had put the weight where it was most needed, for we have not been compelled to resort to any makeshifts, however ingenious they may be, to carry our ships through their trials.

Considerable space is given to showing the insufficiency of engineers in the navy,

"Poldi" Steel.

This is a brand of steel which is now being introduced into this country by The Frasse Company, 19 Warren street, New York, who are agents for the United States and Canada. It is but little known here as yet. Like most modern steels it is made of various qualities to suit different purposes. One brand is for working very hard material, such as chilled rolls, locomotive tires, safe plates, etc.; another for razors and other cutlery; another for mill picks and the like, and so on through various grades. There is also a self-hardening steel for the various purposes for which such steel is used.

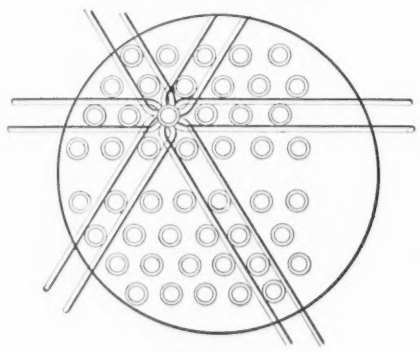


Fig. 5.

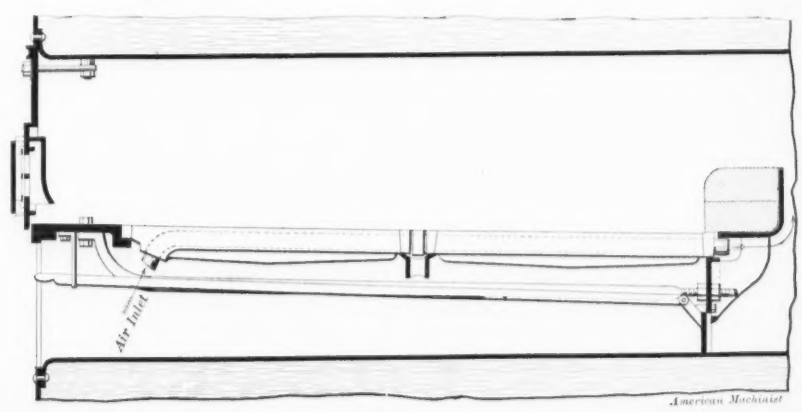


Fig. 9.

and the recommendation is made that they have accorded them their rights and standing. The report says:

Were the navy a mercantile concern the present state of affairs would not last beyond the time necessary to change it, for men with capital invested in machinery see to it that there is a force sufficient to keep it in proper maintenance; and surely if business people find such a course economical the Government can not do better than follow their example. The value of the naval machinery now owned by the Government and in process of construction is about $24,000,000, and it has now come to the point where Congress must decide whether it is more economical to properly care for this machinery and keep it always in an efficient condition, or to let it run on as long as it will and then replace it, taking meanwhile the risk of having it fail when most needed. As an illustration of the increased work thrown on the members of the engineer corps by the acquisition of the new navy, I can state that the "New York" has added 17 per cent. to the horse power of the machinery of vessels in commission; the "Columbia" will add 17.3 per cent. more; and when the ships now authorized and building are finished the horse-power of the propelling machinery of the navy will have increased to nearly *two and a half times its present amount*—and yet we are asked to run it with the same number of engineer officers that we now have.

The officers of the engineer corps at sea on the new vessels have altogether too much work to do now, and it is merely a question of time before the strain will tell. The result of this hard work is being seriously felt; retirements are increasing, and the Government thus subjected to an expense greater than would be involved in now granting a fair increase of numbers, while some of those who manage to complete a cruise in one of the high-powered ships only await a favorable opportunity to resign. Many of our young officers who have resigned to accept lucrative and responsible positions would have preferred to remain in the service if they could have seen any chance of advancement in it.

That the engineers have kept abreast of the times and in touch with modern methods is shown by the positions of trust and emolument that are being offered them, and if the services of these men are of such great value to private corporations they should be of still more value to the Government.

With a view to making the service more attractive to the assistant engineers I again recommend that the steerage be abolished, or at least that all commissioned officers be made ward-room officers. Of the staff officers in the service the assistant engineers are the only ones who spend any considerable time in the steerage; a few assistant surgeons spend two years there, the assistant paymasters are never there, while the assistant engineer may spend six years or more in it. The marine officer is seldom sent to sea in the steerage, while the ensign frequently on his first, and always on his second cruise, is made a ward room officer by being ordered as "a watch and division officer." No such action as this is taken in the case of the assistant engineer, for although he may have charge of a sub division of the engineer division, with more men under him than the ensign has, and perform duty which is in all respects analogous to that performed by the ensign, he is not shown the same consideration.

Coming to the question of conferring positive rank instead of the meaningless "relative" rank now held by members of the engineer corps. I earnestly trust that the department will recommend to Congress some measure looking toward this just and proper recognition of the service performed by the officers of this corps. Why officers devoting their lives to the service, who have always had a certain portion of the crew to organize, muster, discipline, station and drill in the various maneuvers intended to make the vessel efficient and destructive, and who from this time on will have under their control from 25 to 60 per cent of the entire ship's company, should be denied recognition as a military element in a fighting organization would be incomprehensible to any one not familiar with the inside workings of the navy.

Outside of a few people in contact with the navy through business or friends, the country at large knows or cares little about the navy's methods; it pays for and wants a navy organized on sound principles—that is about the extent of its thoughts about it. Were the facts clearly understood I believe that Congress would soon furnish a solution, since the thing asked for costs nothing, usurps no command, and would put questions of rank in the navy on a uniform basis with that in the army. The engineers ask for no authority outside of their own department; they only ask such recognition within it as any person should have who takes the risks and bears the brunt of battle, and who directs the operations of men during it; in other words, they ask Congress to legalize the functions they now perform.

Engineers have been and are being continually spoken of contemptuously as "noncombatants"; the engineers resent these assumptions of those who arrogantly claim all fighting duties, and no cunning evasion or perversion of facts, no statements to the effect that the engineers are influenced by "sentiment," and that they aspire to command ships, can draw attention from the fact that the engineers of to day are "combatants" in the strictest sense of the word, and that as such they should receive proper recognition. The naval battle of the future will be a thing of horror and of sudden wholesale carnage, if nerve directs; the ship will fight with her engines as well as with her guns, and the ram will be a more dangerous weapon and one more feared than the battery; and if her boilers or her engines fail she will become a drifting mass absolutely at the mercy of the enemy.

Let those who decry the engineers as "non combatants" take home the lesson to be learned from the loss of the "Victoria." It was not powder that there worked destruction—it was steam, and if such horror can occur in peaceful maneuvering, what might not happen in time of battle? Here is a ship lost under the exact conditions of battle—rammed by another—and see how the "non combatant" engineers came out of it. "The whole engine-room staff on watch perished to a man"; so says London *Engineering*. . .

Human mind cannot imagine a position of greater nervous and mental strain than is endured by men who in battle are fastened in these death traps. If ever discipline and command of men is needed, it is right here. Surely the man who at a critical moment, by his nerve, training and sense of duty and responsibility, keeps these men at their stations and makes of them a fighting factor that can be absolutely depended upon should be recognized as commanding them, and that by something more than sufferance and the honorary compliment of "relative" rank. It is much easier to control men where they have their danger constantly in sight, and where, if necessity compels, they can jump and save themselves, than it is in an air tight fire room and beneath the battle hatches of an engine room, where the rupture of a steam pipe from any cause means death to all in the compartment. And the officers who do this and successfully aid the captain in carrying out his plan of battle are fully as important and deserving of just treatment as the officers who control the guns' crews and direct the fire of the guns as ordered by the captain. It is a question of men and ability, not one of corps prejudices.

That the engineers are influenced by "sentiment" is perfectly true, and I would be sorry to see it otherwise, for what are honor and courage and patriotism and other feelings that distinguish men from brutes but "sentiment," and what sort of a world would it be without just such "sentiments"?

The contention that the granting of authority to engineers to "command" in their own department will lessen the authority of the commanding officer of the ship is as absurd as it is childish. Marine officers have always exercised "command" over their guards on board ship, but nobody can be found to even intimate that the authority of the commanding officer over the marine guard is any less than if the marine officer did not have this command. The line officers themselves exercise such "command" in their divisions, but we hear of no instance of the commanding officer's authority being thereby lessened. The staff officers of the army have actual rank, and, while a much larger and more complex organization than the navy, the army moves along with a harmony and an exhibition of mutual respect and good comradeship between officers of different departments which speak volumes.

The difficulty of obtaining mechanics to serve aboard ship—machinists, blacksmiths, boiler makers, coppersmiths, etc., is very plainly and correctly set down to the small pay and the lack of consideration they receive. The report says:

If the machinists, when deserving, were given general passes, it would make them feel that they were a more important part of the ship, and might keep many good men in the service who now leave after the first cruise because they think they are discriminated against. A general pass would be equivalent to a reward for good conduct and efficiency, would be prized by any man worthy of it, and would not injure the discipline of the ship any more than it does now by granting it to other chief petty officers.

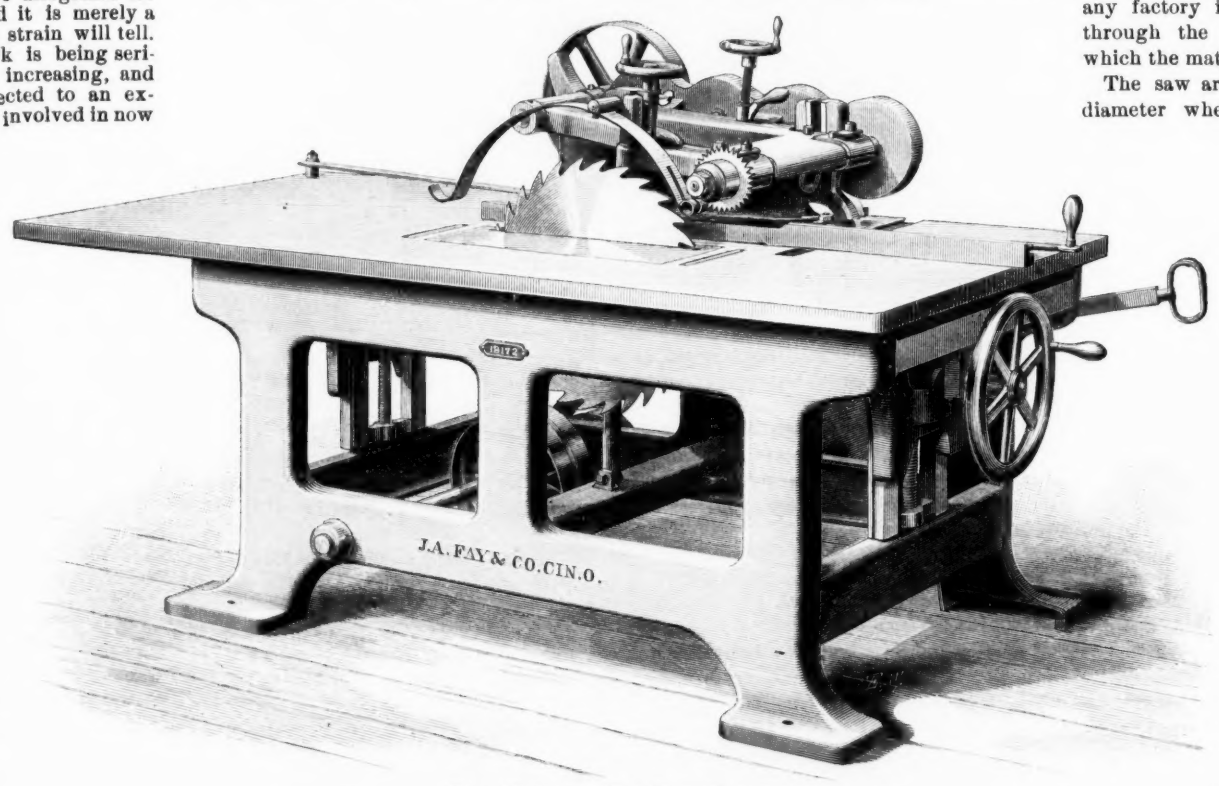
The new regulations (General Order No. 409) make boiler makers, blacksmiths, and coppersmiths second-class petty officers, which means that they will have to wear a blue shirt instead of the petty officer's coat. I believe the effect of this will be bad, for there are few mechanics who care to be dressed as a sailor was in the days of sailing ships. A coat gives the man a more military appearance, gives him a distinction above the men he is in charge of when on watch, and consequently more authority over them.

The pay of the blacksmith and of the coppersmith has been reduced to $50 a month. This is entirely too little for either of them. A good coppersmith on shore can command from three to four dollars a day, and it is idle to think that $50 a month will entice one into the service even with the privilege of sleeping in a hammock thrown in. Our new ships are full of copper pipes, but when an accident of any consequence occurs to one it has to be sent on shore for repairs. Every ship in commission, especially on a foreign station, should be capable with her own force of making any repairs to pipes that may be necessary; but they will not be as long as the present rate of pay for coppersmiths is adhered to and his status on shipboard what it is. When we offered sixty dollars for them they would not enlist, and it would certainly be remarkable if we could now get them for less.

The blacksmith is the most generally useful of all the mechanics and the one whose services are always in demand. A competent machinesmith on shore is paid $3 and upward per day, and, as in the case of the coppersmith, $50 a month is no attraction for them. All of these rates should be first class petty officers and paid the same as machinists.

There is another subject to which I would specially call your attention, and that is the necessity of more specific regulations about the drilling of men of the engineer's force on board ship. To my mind this drilling firemen and coal-passers in duties which they will never have to perform in action is unwise, but if they must be drilled let there be some consideration about it; don't make the performance of the duty for which they were shipped, and which they would have to perform in action, secondary to this drill, and don't make them drill when steaming in the tropics, which is often done.

The report closes with estimates of appropriations required, followed by accounts of tests of some engineering appliances.



SELF-FEEDING RIP SAW TABLE.

Self-feeding Rip Saw Table.

The machine shown in the engraving is designed for ripping material into parallel strips, and for ordinary ripping purposes. It will very greatly increase the product of any factory in which it may be placed, through the speed and regularity with which the material is fed to the saw.

The saw arbor is made of steel, 1⅛″ in diameter where the saw is placed, and mounted substantially in the frame of the machine in three long bearings. It is arranged so that several saws may be used at one time. The driving pulley on the arbor is placed between bearings outside the frame, and may be belted in any direction. It carries a saw up to 22″ in diameter, that will rip material up to 8½″ thick, and the machine will rip as wide as 23½″.

The feed is very strong, and consists of a toothed disk acting on the top surface of the material, in the same line the saw is to cut. It is driven by a train of strong gearing which receives its power directly from a countershaft hung in the frame of the machine. The feeding disk and frame can be raised or lowered to suit material of different thicknesses, or thrown back out of the way when the operator desires to do ordinary hand ripping, and the disk shaft has an adjustment for throwing the disk out of line sufficiently to lead the material to the fence. The machine is regularly fitted with two rates of feed, viz., 85 feet and 115 feet per minute.

The table is usually made of wood, 78″x 38″, and it raises or lowers parallel with the frame, being operated by the hand-wheel and screws shown. It is faced with steel where the greatest wear takes place, is surmounted by a movable fence that is quickly adjustable across the surface of the table to suit the width of material to be sawed, and which has an angle adjustment to give to the material the proper clearance as it leaves the saw. Friction rolls are placed in the table just before and after the saw to relieve the material of friction. When desired an iron table is furnished in place of the usual wooden one.

The machine is made by J. A. Fay & Co., Cincinnati, Ohio.

An Ignorant Captain.

Old Lady—What is the matter now?

Steamboat Captain—We've run on a sand bar.

Old Lady—Well, why don't you go over it? What's your walking beam for, I'd like to know?—*New York Weekly.*

The Effects on the Diagrams of Different Pipe Connections to Indicator.

BY EDWARD J. WILLIS, M. E.

The following experiments were made upon a high speed engine to ascertain what effect various sizes and forms of pipe connections between the indicator and cylinder had upon the indicated horse-power. The engine selected for these experiments was a Ball engine 10-inch diameter cylinder, 12-inch stroke, and making about three hundred and ten revolutions per minute. The load of the engine was very steady, and was easily controlled by throwing in or out sets of lights of the private electric plant of which this engine is a part. The method of the test was to compare the horse power given by an indicator with direct cylinder connection with the horse-power given by an indicator whose connection with the cylinder was through certain complicated pipe connections as described further on. The two indicators used were duplicate Crosby instruments whose readings agreed quite closely in a test reported in the AMERICAN MACHINIST of August 31st. The two 60-pound springs which were in the indicators during the experiments were tested both before and after using, with live steam against a mercury column. Short cords of equal length were put on the indicators, the drum springs adjusted to the same tension, and indeed everything done to place them under exactly the same conditions, except as to pipe connections. Further to prevent any unknown differences in the instruments affecting the average results the indicators were transposed during each test, so that half the cards were taken with them in one position, and half with them in the other position. All the cards taken are given in the table below, and none were left out to make the figures agree more closely.

One indicator cock was screwed into the cylinder at the usual place as shown in the first sketch, and the reading of this indicator will be found in the table under the head of "Direct Connection." The other indicator was connected with the same end of the engine cylinder at a special tapping leading to about the same point in the interior of the cylinder as did the direct connection. This indicator had various complicated pipe connections, one of which is shown in the first illustration, and its reading will be found under the head of "Indirect Connection."

TABLE.

	Boiler Press.	Revolutions.	Spring used.	Mean Effective Pressure. Direct Connection.	Mean Effective Pressure. Indirect Connection.	Horse-Power. Direct Connection.	Horse Power. Indirect Connection.	Indicator used.
Test No. 1.	80	312	60	27.07	27.72	20.1	20.6	7 & 5
	80	312	60	28.34	28.02	21.0	20.8	7 & 5
	80	312	60	30.17	28.91	22.4	21.5	5 & 7
	80	312	60	31.87	31.06	23.7	23.1	5 & 7
	Averages.			29.36	28.93	21.8	21.5	
Test No. 2.	80	313	60	27.64	28.06	20.5	20.9	5 & 7
	80	313	60	27.78	28.06	20.7	20.9	5 & 7
	80	313	60	26.79	26.93	20.0	20.0	7 & 5
	80	313	60	16.36	16.36	13.2	13.2	7 & 5
	Averages.			24.64	24.84	18.4	18.5	
Test No. 3.	80	313	60	27.78	27.11	20.7	20.2	7 & 5
	80	313	60	27.64	27.50	20.5	20.5	7 & 5
	80	313	60	27.07	27.07	20.1	20.1	5 & 7
	80	313	60	26.09	26.52	19.5	19.2	5 & 7
	Averages.			27.14	27.05	20.2	20.1	

In the first test 24 inches of ½ inch pipe and one ½-inch elbow were put between the cylinder and the indicator whose readings are under the head of "Indirect Connection"; the other instrument, as before stated, had no pipe at all. It would appear that the friction of this piping had reduced the average indicated horse-power a little over one per cent. This, however, is not sustained by the next test which had the same length of ½-inch pipe, but two more elbows and a ½ inch valve in addition; making a total resistance of 24 inches of ½-inch pipe, and three ½ inch elbows, and one ½-inch valve. It will be noticed that in this test the indirect connection gave the highest average result. In the third test the diameter of the pipe was reduced in order to observe what effect, if any, this would have on the readings. In this case, as shown in the first illustration, ⅜-inch pipe and elbows were substituted for some of the ½-inch piping, giving a total resistance of 18 inches of ½-inch pipe, 6 inches of ⅜ inch pipe, a ½-inch valve and a ½-inch elbow, two three-eighths elbows and a reducer half inch to three eighths. This piping as will be noted in the sketch was arranged to let any water condensing in the pipe run back to the cylinder to prevent the possibility of a water hammer. Even this peculiar combination of piping, it will be noted, apparently only reduced the average horse-power one-half of one per cent. The writer has found, from previous experiments, that, even with the greatest care, it is almost impossible to get two indicators to give the same reading, when so far as can be seen, the instruments are under exactly the same conditions; and he is inclined to think that the slight disagreements shown in the table are rather due to unavoidable variations than to the friction of the piping used. The cards have in general the appearance of duplicates, and as a rule a tracing of the direct card fits very nearly the card taken by the indirect connection. The only noticeable difference between the cards is that the expansion lines of the indirect cards are more wavy than those taken through the direct connection. This may be due to oscillations of the steam in the long pipe. It does not, however, affect the mean effective pressure, as the tracings show that the wavy line of the indirect connection is very neatly run through by the more steady line of the direct connection, leaving about equal areas on either side. It is a mistake to draw a universal conclusion from so limited a test, but the figures unquestionably point to the fact that the usual instructions for close pipe connections are unnecessary. The prejudice on this point often prevents the use of a more convenient position for the indicator. Further, if the above be true, the existing preference for the use of two indicators is unfounded, as the probable error due to the pipe connections necessary when using one indicator is less than that probably caused by the extra lengths of cord necessary when using two indicators.

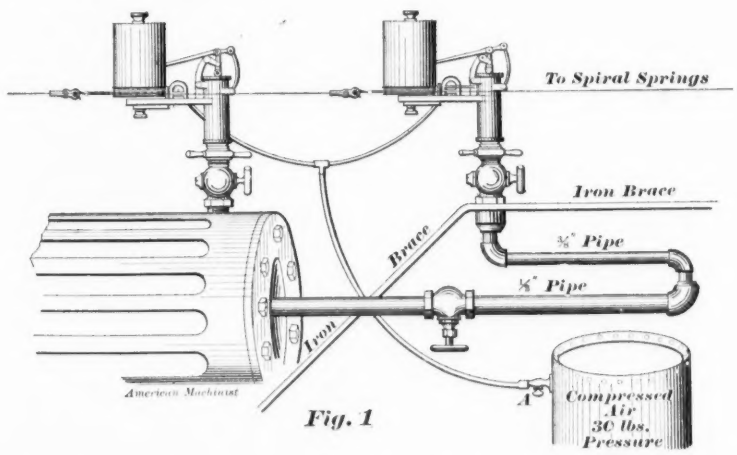


Fig. 1

The details arranged for the simultaneous action of the two indicators may prove of interest. A hard drawn wire was stretched from the "Brombo" pulley back to four strong spiral springs. To this wire the short indicator cards were attached by little clamps like the one shown in sketch No. 2. This clamp was designed by the writer and is most admirably suited for the purpose. It clamps on the hard drawn wire without bending it and never slips. It is small and light, and easily adjusted along the wire so as to prevent the indicator drum from hammering at either end of the stroke. In order to make sure of taking cards at the same stroke with both indicators the pneumatic arrangements shown in the illustrations were made use of. In the first cut it will be seen that by opening cock *A* air under 30 pounds pressure will be admitted to two small pistons, one on each indicator. These pistons press the pencils against the drums. The last cut shows more plainly the method of operation. The small spring *a* keeps the pencil about a sixteenth of an inch off the paper on the drum. When the compressed air enters the piston *b* through the tube *c*, it immediately turns slightly the swivel head of the pencil movement and presses the pencil on the paper. As soon as the air pressure is released the little spiral spring *a* withdraws the pencil from the drum. The writer has made this plan operate quite a number of indicators at a time and they all worked with a promptness very similar to the action of the emergency stop of the air-brake system.

Fig. 2

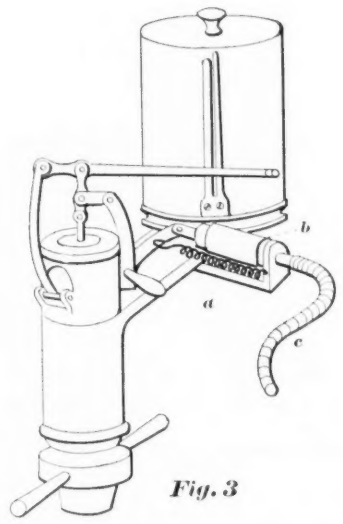


Fig. 3

Says Joshua Rose is Not a Plagiarist—Mr. Durfee Misinformed.*

NEW YORK, Nov. 10, 1893.

Mr. Horace L. Arnold:

DEAR SIR—Referring to our recent conversation at the World's Fair at Chicago, it has occurred to me to ask you to be good enough to state in the columns of the AMERICAN MACHINIST (in which Mr. Durfee made and reiterated his personal attack) your knowledge as to the actual facts of the cam question, *i. e.*, as to whether I did or did not write the articles on cams which Mr. Durfee attributes to Mr. Partridge and states were plagiarized in my book "Modern Machine Shop Practice." Had Mr. Durfee's letter met my eye at the time, or about the time it appeared in print, I should have probably refuted it at once, but I saw it for the first time when coming over on the "Lucania" lately, and have been too busy at the World's Fair, and in noting the progress made in engineering matters in the United States during the past few years to enter into any petty wrangles or disputes. If Mr. Durfee finds amusement, pleasure or profit in injecting into a most interesting discussion on cam designing, personalities, assertions and charges of plagiarism, while knowing nothing of the facts, he is welcome to his delight. As for me I am content to refrain from bringing in any more witnesses, for, while I am much interested in the discussion of mechanical problems, I am not interested in discussing such personalities and vituperation as may be brought into them. It is sufficient for me that I wrote the articles, and Mr. Jordan does not claim the authorship of them, but was and is quite content with the matter. Since, however, Mr. Durfee has brought in Mr. Partridge, let me say that I believe either you or Mr. Partridge did write an article on the cam question, but that was not my article, and as you are of all others the best acquainted with the whole matter, will you be good enough, without fear or favor, to give to the AMERICAN MACHINIST the benefit of your personal knowledge upon the subject.

I once knew an old millwright who said to me when a boy: "All machines are composed of the following elements: Screws, gears, cams, eccentrics, pulleys, levers, cranks, pistons, cylinders, etc., and all you can do is to arrange their mechanism in a way to accomplish your object by the aid of these devices in the most direct, durable and efficient manner, and your arrangement is yours and that is all that is yours. Never get to believe, young man, that you have done it all, for your forefathers have done much." Of course, there is some truth in this, but I think Mr. Leicester Allen's most interesting articles in the AMERICAN MACHINIST show that there is another side to the question even though every problem he enunciates involves some one at least of the elements of mechanism the old millwright put forth as the groundwork.

In conclusion let me say that to watch and study the strides that are being made in machine and engine construction are of too much interest to me to leave any time for entering into discussions as to how far this or that meritorious designer is indebted to his mechanical progenitors. That I leave to those who, being of a negative disposition, like to be bellicose.

Yours very truly,

JOSHUA ROSE.

NEW YORK, Nov. 11, 1893.

Mr. Joshua Rose:

DEAR SIR—Replying to your esteemed favor of the 10th inst. I would make the following statement of facts in regard to your article on "Cams and Cam Motions" in *Mechanics* published in 1883 or 1884. At that time we met, often and I had, if my memory is not in fault, contributed one or two articles on cams to the columns of *Mechanics*. You came to me and told me you wished what information I could give you regarding cams in general, and I replied in substance that while I was willing to give you all the information I had on the subject, your better way was to apply directly to Mr. Edmund Jorden (not Jordan, as the name was erroneously printed as author of the disputed article in *Mechanics*) since he had a much greater experience that I in cams, and was perfectly ready to communicate any information in his possession to any one seeking facts. You did interview Mr. Jorden, who was at that time and for many years previously superintendent for E. W. Bliss, of Brooklyn, and had for a long time before held the same position with Blake & Johnson, the widely known Waterbury firm of automatic tool and machine builders, and who was previously to that time one of the old school of pioneer mechanics on the upper waters of the Naugatuck River, and hence abundantly qualified by practice to speak of the subject in question, and showed me the article in question which you had written, and to which you had, acting under a general permission from Mr. Jorden, given his name as author, because, as you said, you considered him better authority at that time than yourself. This article, however, was printed without having been seen by Mr. Jorden, and had you not been unusually scrupulous about giving credit, would never have borne Mr. Jorden's name, as he gave you the information freely, with explicit permission to use it as your own, and as you saw fit, and, furthermore, as from the gen-

* The letters herewith are published by request and must end the controversy regarding the matter referred to.—ED. A. M.

eral information on "return" cams given you by Mr. Jorden, you had worked out several specific problems, making sheet metal templates, and verifying all particulars in your usual painstaking manner, a course which I considered made you fully entitled to regard the work in question exclusively your own.

I will say further that I was on the point of correcting Mr. Durfee's error in the AMERICAN MACHINIST at the time his aspersions of your honesty were made, but upon reflection decided to let the matter rest until I was sure you wished it noticed.

In order to make this whole matter certain I have examined a file of *Mechanics* and find there were two "Jordan" articles in Vol. 4 of *Mechanics*, 1883, on p. 252, "Cams for Steam Engine Cut-offs," and on p. 300, "The Construction of Cams." I called on Mr. Jorden this morning, and in answer to my inquiry he told me that you had a full right to use the cam matter as you did, and that he himself never had written and never would write an article for publication, and that he never wrote and never saw the articles in controversy before they appeared in *Mechanics* My own articles on "Cams" in *Mechanics* were Vol.1, p. 84, a reproduction of several of my drawings of cam actions, and Vol. 1, p. 170, "The Return Cam," with 13 figures, and possibly others which I do not now remember.

In conclusion I will say that, in brief, you were the sole and undisputed author of the article in question, to which you, as a matter of courtesy and extreme regard for first sources, gave Mr. Jorden's name.

Respectfully,

HORACE L. ARNOLD.

The Stability of Our New War Vessels.

The recent accounts in the daily press of the fear that some of our new war vessels are unstable, or in other words, might upset under certain conditions, have undoubtedly drawn attention to this subject, and probably many of our readers have been puzzled by unfamiliar terms, such as "metacenter." We shall, therefore, give a simple explanation of stability, metacentric height, etc., so that readers interested in the subject, but who are unacquainted with naval architecture, can understand it intelligently.

Referring to Fig. 1, which represents a cross section of a ship, the point B represents the "center of buoyancy," which means simply the center of gravity of the volume of water displaced by the vessel; G is the center of gravity of the vessel herself, and for the same total weight its position depends on the location of the components of that weight, as might be expected; M is the metacenter, which we shall now explain.

It will be noticed that in the figure the ship is represented as inclined or heeled through a moderate angle. B is the center of buoyancy for this inclined position, while B_1 is the center of buoyancy for the upright position. The point M is the intersection of the vertical through the center of buoyancy, when the ship is inclined at a small angle, with the vertical through the center of buoyancy and center of gravity when the vessel is floating upright. This point is the metacenter, and is defined as the point which will fulfill the conditions just stated.

The distance from the metacenter M to the center of gravity G is called the "metacentric height," and has a very important bearing upon the stability of the vessel. It is shown in all works on naval architecture that the metacentric height is a measure of the vessel's stability. In fact, the action is similar to that of a pendulum in which M is the point of suspension, G the weight—in this case the whole weight of the vessel or her displacement—and $G\ M$ the length of the pendulum. The force tending to restore the vessel to an upright position when she has been heeled from any cause is equal to the weight multiplied by the distance $G\ Z$, which is equal to $G\ M$ into the sine of the angle of inclination. The smaller $G\ M$ is, therefore, the less the "righting moment" or force tending to bring back the vessel to the upright position.

It is, therefore, of great importance in all vessels that the metacentric height should be sufficient to insure stability under all conditions of loading. It might appear at first sight that nothing would be easier than to give a considerable value to $G\ M$, which would allow for considerable variation in the position of the center of gravity, but there are other important considerations which interfere.

We may explain, in the first place, that the position of M, the metacenter, does not depend at all on the center of gravity of the vessel, but on the form of the load water line and the volume of displaced water. In fact, it is located at a distance from the center of buoyancy equal to the moment of inertia of the load water plane divided by the volume of displacement. The exact determination of the former requires considerable work unless the modern calculating machines are used, but it may be expressed approximately as the product of the length by the cube of the breadth, and this by a constant depending on the shape of the water line. For extremely fine lines the constant is about .04; for moderately fine lines .05 to .055; for full lines .06 to .065, while a rectangle would be exactly .083. The volume of displacement for salt water is simply the displacement in tons multiplied by 35, the number of cubic feet in a ton. Inasmuch, however, as the displacement is equal to the product of length, beam and draught by a constant, we can reduce the formula for metacentric distance from center of buoyancy to another form, in which $B\ M$ is equal to the square of the breadth at water line multiplied by a constant and divided by the mean draught; the constant in this case is from .09 to .1 for ships of ordinary shape, and .08 to .09 for ships of full forms. From this second formula it is seen how important beam is for stability, a fact of which every one is aware by actual experience.

The position of the center of gravity of the vessel depends on the distribution of weight in the vessel, and except by inclining experiments, which we shall describe presently, can only be found by calculation, a very tedious process. In getting out the design of a vessel, the weights and positions of the various components of the ship are estimated as closely as possible, and when the persons doing the work are skilled, the result comes out very closely to the actual position.

It is thus seen that the metacentric height depends on the position of two points, which, however, are entirely independent of each other. The metacenter is the one which can be varied most easily, as we have just seen that its distance from the center of buoyancy varies as the square of the breadth, while in general the position of the center of gravity cannot be varied at the desire of the designer, but must fit the weights to be carried.

We remarked that it might seem easy to have almost any metacentric height, and barring the influence of the form of the vessel on speed, it might if it were not for the question of easy rolling at sea. Excessive metacentric height would make the vessel remarkably stable or secure against capsizing, but if it exceeds a certain amount the vessel would be extremely uncomfortable. In consequence of this fact, the naval architect finds it necessary to limit the metacentric height to an amount found to give comparative ease of rolling with satisfactory stability. Of course it often happens, as in the case of our monitors, that the dimensions imposed by the conditions of service will give a value for the metacentric height which would not be selected if the designer were perfectly free.

In most of our modern war vessels of moderate size, the designed metacentric height is from two to three feet, but in very broad ships it will be greater, the "New York," for instance, having nearly five feet, according to a recent publication.

In war vessels the weights do not vary greatly, as the stores, coal and ammunition are the only things which change, so that the metacentric height remains practically the same at all times. In merchant steamers, on the contrary, the nature and distribution of the cargo may vary so greatly that ballast has to be depended on to a great extent. In the case of war ships, if it should happen that the weights are changed from the original intention, especially if they are increased when above the center of gravity, it would become necessary also to resort to water ballast to secure stability.

From what we can learn of the trouble with our new vessels, it would appear that the difficulty is partly due to increase of weights carried above the center of gravity, but it looks as if there must have been some error in the original calculations, or perhaps the value of the metacentric height was so moderate that a small increase in the height of the center of gravity would materially reduce it. At the same time, we do not believe that the vessels in question are dangerously unstable, as we have no doubt that there still remains a certain amount of metacentric height. The point is, as we have already shown, that any reduction in the metacentric height makes the righting force less, and therefore there is less margin for unforeseen contingencies. In other words, a vessel whose metacentric height was intended to be two or three feet will not turn over, because it is reduced to six inches or a foot, as long as everything goes well; but she would capsize under circumstances where she would have been perfectly safe with the greater value. The proper metacentric height can be obtained by filling the double bottom (when there is one) with water ballast, but this increases the displacement and reduces the speed, and thus is a makeshift. We are informed, however, that some war vessels always go to sea with several hundred tons of water ballast in the double bottom.

The inclining experiments to which we have already referred enable us to determine accurately the position of the center of gravity with reference to the metacenter, and this without any tedious calculation.

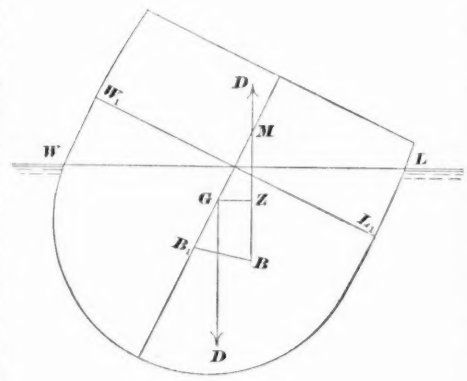


Fig. 1

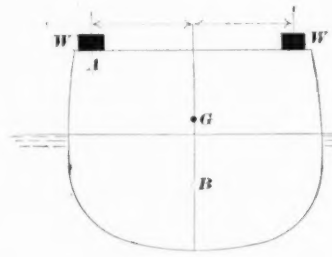


Fig. 2

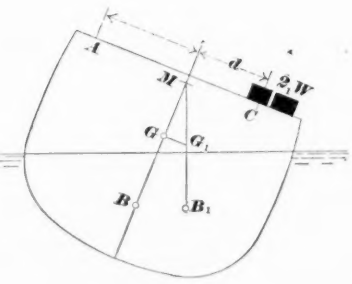


Fig. 3

When they are conducted everything is on board, so that we know that the position found for the center of gravity is the actual one, while calculation is necessarily based on estimates of weights of various parts which may vary, so that we cannot be sure that we have allowed for all the variations, or that, as might be the case, all the variation had not gone one way, instead of averaging so as to neutralize the errors of excess and defect.

The diagrams in Figs. 2 and 3 show the principle of inclining experiments. All weights which might shift must be secured, the boilers must be empty or else completely filled and the bilges must be dry. A calm day is desirable, but if there is any wind the ship should be placed head on to it, so that it will not affect the inclination.

For the purpose of producing the desired inclination, piles of ballast are usually placed on the deck ($W\ W$, Fig 2,) being at first evenly divided on the two sides, but in some cases the guns are moved from side to side instead of using ballast (this, of course, in the case of war vessels). Two or three long plumb lines are hung in the hatchways, and by means of these lines the degree of inclination from the upright is noted.

All being ready, and the ship at rest, the position of the plumb lines is marked and the draught of water taken. The position of the metacenter for this draught can be calculated, as already explained, from the drawings of the vessel. Next a known weight of ballast (W, Fig. 2,) is moved across the deck through a known distance. The vessel heels over and after a short time comes to rest in this new position, or in other words, is once more in equilibrium, as shown in Fig. 3. Consequently, for this new position the metacenter must be vertically above the new center of gravity (G_1), for obviously the shift of ballast has moved the center of gravity of the whole ship through a certain distance $G\ G_1$ parallel to the deck, and it is this movement of the center of gravity that produces the inclination.

Now as $G\ G_1$ is perpendicular to the line $G\ M$, we have by trigonometry that $G\ G_1$ is equal to $G\ M$ multiplied by the tangent of the angle of inclination, or $G\ M$ equals $G\ G_1$ multiplied by the co tangent of the inclination. It now remains only to find $G\ G_1$, as we determine the angle by inspection. $G\ G_1$ is equal to the weight moved multiplied by the distance through which it is moved and divided by the weight of the ship, *i. e.*, the displacement in tons.

In practice, it is usual to subdivide the ballast on each side into two piles, and make four observations of the inclinations produced by (1) moving one pile of ballast from port to starboard; (2) moving the second pile from port to starboard; the two piles are then restored to their original position, and the same course is followed for the two piles on the starboard side. The value of the metacentric height should be deduced for each experiment, and the mean of all four is taken as the true value of the metacentric height at the time of the experiment.

The reason for securing all other weights that they may not move, and preventing any free movement of water either in the boilers, tanks or bilges, is that the weight of ballast moved is usually small relative to the displacement of the vessel, so that if any other weights are free to move, the result would be seriously vitiated.

Experiments such as here outlined are, we understand, to be conducted with the new vessels whose stability is questioned, and whatever the result, a great amount of very useful information will be obtained, which, we trust, will be published by the Navy Department for the benefit of all persons interested in shipping.

Our explanation is based upon the "Manual of Naval Architecture," by Dr. W. H. White, Chief Constructor of the British Navy, from which we have also taken the illustrations. Those of our readers who care to investigate the subject thoroughly may consult that work, which treats of the problems of naval architecture at length.

LETTERS FROM PRACTICAL MEN.

Grinding Lathe and Planer Tools—A Machine Shop "Hold Back."

Editor American Machinist:

It is often a difficult matter to stop a small waste without causing another as large or larger. There is often more to do when we start to remedy a difficulty than we at first think.

It seems to me that, following the conveniences now adopted, the grinding of such lathe and planer tools that require correct angles and straight edges, is a little slow in receiving proper attention. To grind a thread tool correctly—"free hand"—without taking too much time, and without doing any damage to the workman's patience, requires a wheel that is true and even.

It is a hard matter to keep a wheel true enough for a nice job, where it is used for rough grinding on all kinds of work.

There is more money wasted in grinding wheels and in truing devices, caused by the necessity of truing wheels for an occasional nice job, when for most others they are plenty good enough, than is commonly thought.

Now add to this the amount of time wasted, and the amount of bad feeling against that grinding wheel, that thread tool, and the machinist business in general at times, and I think there is ample reason why we should have something better.

A friend was telling me of a machinist who owned and operated a machine shop mostly himself alone, but at one time on account of an extra rush of business, hired four or five men. He had made rules in that shop that seemed to work best with the least help. One of them was in regard to a certain thread tool that he had filed to the gauge himself, and the orders were that it must not be ground, "because it was just right." My friend says it was not ground while he was there, although it needed it bad enough. Several years ago I started to make drawings of a little machine that I hoped to introduce into machine shops for the special purpose of grinding such tools as require straight edges and correct angles, but I found before I had gone far, that there were already such machines upon the market that would do much more than I thought of attempting.

In fact, so much more that it seemed to me like starting too much of a reform at once. I should not have thought it possible to introduce an expensive machine for grinding all kinds of lathe and planer tools by mechanical means, but it seems that it is possible, and so much the better, for it is hard to get too much of a good thing.

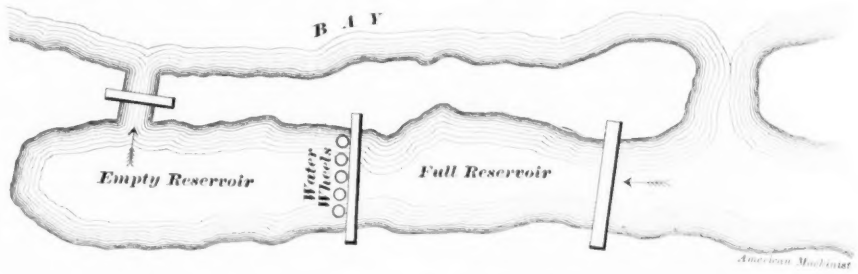
Grinding wheels are used more on such machines for grinding useful work, and less at grinding the truing device.

It is safe to say that in all cases where the work can be held firm and steadily fed across the grinding wheel, there can be the most work got out of the wheel, and the least "monkey business."

I have no doubt in a large shop it is the best plan to have one man attend to the tool grinding. There should be plenty of spare tools, so there would be no waiting for a sharp one. The tools should be kept within easy reach of the men who are to use them. To cause a delay in getting a sharp tool as long as it will take to grind the dull one by the old way, is to defeat the whole business.

Suppose it is made one man's business to grind tools and put them in places where they can be easily got at. Could it be depended upon, in most shops, that the dull ones could be easily found by the man who has to grind them? I think not. There are a few careless ones in most shops who prove to be the greatest "hold backs" to all conveniences. Is Mr. Jones so very much to blame if he throws his tools under the bench, when he finds that Mr. Brown is allowed to do so? You may lock the tool grinding machine in the tool room, and make it possible to get a sharp tool by presenting a dull one at the window, accompanied by a written order from the foreman, and you may allow the tools to be ground on the old grindstone, and start a loafing school in the shop, without much difference in the result. It should be better understood that a man's time is used to just as good advantage when he is putting tools away where it is convenient for some other man to get them, as when he is scraping away at a vise, or doing anything else. If every man was paid just what he is worth in the shop, I believe there are a great many who are now counted good workmen who would not get a cent. A man may do good work himself, but so hinder others that his own value is destroyed.

If a man found his pay reduced on account of his carelessness in the shop in taking care of tools, as he certainly would if he made a practice of spoiling every other job, then there would be an inducement for him to do better, or make room for some one who would. A MECHANIC.



Tidal Powers.

Editor American Machinist:

Many attempts have been made to utilize tides for power purposes, but as far as I know there have been no successful attempts that have given enough power to more than turn a good-sized coffee mill. I have seen one of these small powers in successful operation in a small estuary near the mouth of the St. John's River in Florida It consisted of a large undershot wheel that was turned by the current flowing in or out, and drove a small mill for grinding corn. It worked quite successfully during certain hours of the day, but as a practical method for obtaining any considerable amount of power it amounted to nothing.

There is a method, however, by which large powers can be derived from the action of the tides, and there are many places along our sea board where the plan can be put into successful operation at a comparatively small expense. The essential elements of the plan are two reservoirs in connection with the sea, one of which is kept full by water flowing through inwardly opening valves at high tide, and the other of which is kept empty by permitting the water to flow through outwardly opening valves at low tide. Water-wheels and connections between the two reservoirs complete the power-producing outfit.

There are numerous lagoons, bayous and inlets along our coast line that furnish ready-made reservoirs, which can be converted into power producers by a little pile driving, and at a much less expense than the cost of the average mill-dam. Lagoons that lie parallel with the shore line (and their name is legion) are likely to be found the most convenient and the most easily utilized. The way this may be done with an ordinary lagoon is shown in the accompanying sketch, which will probably be sufficiently clear without additional explanation.

The amount of power that can be obtained in a case of this kind will depend upon the height of the rise and fall of the tide, and the area of the reservoirs. The reservoirs should be as near the same size as economy in the cost of construction will permit, as the power will be restricted by the smaller of the two. If we assume an area of one square mile between the inlet and outlet gates equally divided between the two reservoirs, and a rise and fall of six feet, then we could run off a depth of two feet over the area of one-half of a square mile every 12 hours, and maintain an almost uniform head of four feet. After deducting 50 per cent. for losses of various kinds, this would give a net of about 150 horse power. In many cases available lagoons are much larger than one square mile, and consequently could be the source of a much larger power. In other cases the tide has a greater rise than six feet.

It is true that available lagoons are seldom close to the place where power is wanted, or where power can be advantageously used, but unless the distance is too great the power could be transformed in electrical energy, and carried over a wire to a convenient place. Power derived in this way would not be influenced by ice or dry weather, but would be practically constant 24 hours in the day, and 365 days in the year. It could be used for power purposes during the day time, and illumination at night.

There are numerous towns and villages scattered along our sea-coast where such powers could be advantageously used for both manufacturing and municipal purposes. That it has not been so used is probably due to the fact that it is not known. I shall be exceedingly gratified if this small article shall be the means of causing the plan to be put into practical use.

C. L. REDFIELD.

A New Friction Driven Drill.

We illustrate herewith a drill press for light work built by the Stover Novelty Works, Freeport, Ill.

It will be noticed that with the friction wheels arranged as in this machine, *i. e.*, with the driver disk movable across the face of the driven disk to change the speed, the

driving power, or, scientifically speaking, the moment of the force which rotates the spindle varies with the size of drill used, being greatest at slow speeds when relatively large drills are used, and least at high speeds when small drills are used—a special feature of this drill, and a good one.

The large disk on the spindle of this machine is always out of contact with the driver when not in use, thus preventing the formation of flat places on the leather-covered disk, which are apt to form where the disks remain at a standstill for some time in contact with pressure. The friction disks in this machine form or rather take the place of the spindle collar and thus take the upward thrust, thus relieving the machine of much friction and wear by changing rubbing friction that performs no useful service into rolling friction that is needed to operate the machine. Arranged thus the spindle starts and stops automatically.

The machine will drill from 0 to $\frac{5}{8}$" and to center of 10" circle. Greatest height from base of drill to spindle 42"; greatest height from table to spindle, 32½"; diameter of column, 3⅜"; diameter of spindle, ⅞"; size of table, 9x11"; vertical motion of spindle, 3¼"; spindle fitted for No. 1 Morse taper.

The Planer at the Charleston Navy Yard.

In our description of the largest and heaviest machine tool shown at Chicago—the 144" planer exhibited by the Niles Tool Works—we stated that only one other planer in this country, so far as we knew, would take larger work. A reader then inquired as to the size of the Charleston Navy Yard planer, and in response to a letter of inquiry addressed by us to the Bureau of Steam Engineering, its Chief, Commodore Melville, writes as follows:

1. The Bureau acknowledges receipt of your letter of the 2d inst. asking information concerning the large planing machine in the steam engineering machine shop of the Boston Navy Yard, and, in reply, informs you as follows:

2. The machine was designed by Seth Wilmarth, formerly master machinist, and built in the machine shop in which it now stands. It was designed for use as a planing machine only, and was completed as such in 1868, but since that time slotting and boring attachments have been fitted by which, for instance, the ends of a propeller hub may be planed off, the hole bored at any taper, and the keyway slotted, all with one securing of the propeller to the platen of the machine. The machine will take work 18 feet 1 inch in width between the shears, 12 feet high over the platen, and has a travel of 26 feet 10 inches. Work can be planed lengthwise or crosswise of the platen.

3. The weight of the machine is not accurately known, but it has been calculated to be about 200 tons.

Very respectfully,

GEO. W. MELVILLE,

Engineer in Chief U. S. N. Chief of Bureau.

A daily paper in speaking of the Hotchkiss guns supplied to Brazil, says these guns are very nicely constructed by the Pratt & Whitney Company, and that a part of a gun that varies from standard more than *three one hundredths* of an inch is rejected by the inspector. Remarkably fine work that!

Mr John Richards, editor of *Industry*, and Mr E. P. Watson, editor of *The Engineer*, have our thanks for their candidly expressed (and published) opinion to the effect that our description of the machinery shown at Chicago is the best that has appeared in any journal. We have tried to make our report of the machinery features a good one, and are, of course, gratified to know that our efforts have been appreciated by those so well qualified to judge them.

The transatlantic steamship companies conclude that not more than 25,000 passengers passed through New York to Chicago from ocean steamships. It was expected that the number would be many times greater.

According to a computation by Commissioner Farmer, of the Trunk Line Association, from April 25th to October 30th, inclusive, there were carried from New York City and Jersey City to Chicago about 137,000 passengers. Of these 70,000 went on one-way tickets, 42,000 on regular excursion tickets, and 25,000 on the half fare day coach excursion tickets. These 137,000 passengers, it is calculated, paid, going and coming, about $4,610,000.

AMERICAN MACHINIST

Communications relating to the reading columns should be addressed to the Editor. All other communications should be addressed:

AMERICAN MACHINIST,
203 BROADWAY, NEW YORK.

PUBLISHED WEEKLY AT
203 Broadway, New York.

HORACE B. MILLER, Pres't and Bus. Manager.
LYCURGUS B. MOORE, Treas. and Sec'y.

F. F. HEMENWAY, Editor and Mech. Engineer.
J. G. A. MEYER, } Associates.
FRED J. MILLER, }

Special Announcements.

☞ *Positively we will neither publish anything in our reading columns for pay or in consideration of advertising patronage. Those who wish to recommend their wares to our readers can do so as fully as they choose in our advertising columns, but our editorial opinions are not for sale.*

☞ *Every correspondent, in order to insure attention, should give his full name and address, not for publication, but as a guarantee of good faith.*

☞ *We are not engaged in procuring patent rights, or in selling machinery, nor have we any pet scheme to advance, or hobby to ride.*

☞ *We invite correspondence from practical machinists, engineers, inventors, draftsmen, and all those specially interested in the occupations we represent, on subjects pertaining to machinery.*

☞ *Subscribers can have the mailing address of their paper changed as often as they desire. Send both old and new addresses. Those who fail to receive their papers promptly will please notify us at once. Date on wrapper denotes week with which subscription expires.*

Subscription.

$3.00 a year in advance, postage prepaid, in the United States, Canada, and Mexico.
$4.00 a year to Other Countries, postage prepaid.

Advertising.

Transient, 35c. per line, each insertion.
"Business Specials," 50c. a line.

The American News Company,
Publishers' Agents, New York.
DEALERS SUPPLIED BY

The Albany News Company, Albany, N. Y.
The American News Company, New York, N. Y.
The Baltimore News Company, Baltimore, Md.
The Brooklyn News Company, Brooklyn, N. Y.
The Buffalo News Co., Buffalo, N. Y.
The Central News Company, Philadelphia, Pa.
The Cincinnati News Company, Cincinnati, Ohio.
The Cleveland News Company, Cleveland, Ohio.
The Colorado News Company, Denver, Colorado.
The Detroit News Company, Detroit, Mich.
The International News Company, New York, N. Y.
The Minnesota News Company, St. Paul, Minn.
The Montreal News Company, Montreal, Canada.
The National News Company, New York, N. Y.
The Newark News Company, Newark, N. J.
The New England News Company, Boston, Mass.
The New Orleans News Company, New Orleans, La.
The New York News Company, New York, N. Y.
The Northern News Company, Troy, New York.
The Omaha News Company, Omaha, Neb.
The Pittsburgh News Company, Pittsburgh, Pa.
The Rhode Island News Company, Providence, R. I.
The San Francisco News Co., San Francisco, Cal.
The South West News Company, Kansas City, Mo.
The St. Louis News Company, St. Louis, Mo.
The Toronto News Co., Toronto, Ontario, Canada.
The Union News Company, New York, N. Y.
The Washington News Company, Washington, D. C.
The Western News Company, Chicago, Ill.
The Williamsburgh News Co., Brooklyn, E. D., N. Y.
The Wisconsin News Company, Milwaukee, Wis.

The International News Company,
BREAM'S BLDG'S, Chancery Lane, LONDON, E. C., ENG., or Stefanstrasse 18, LEIPZIG, GERMANY, will receive subscriptions for the AMERICAN MACHINIST, at 16/6 per annum, English currency, or 17 marks per annum, German currency, postpaid.
Subscriptions received in Paris, France, by E. TERQUEM, 31 Boulevard Hausmann, at 20 francs per annum, postpaid.

Subscriptions received in Australia by W. WILLIAMS, 17 and 21 Fink's Buildings, Melbourne.

NEW YORK, NOVEMBER 23, 1893.

CONTENTS.

	PAGE.
Some Notes on Indicator Reducing Gear. By M. E.	1, 2
Notes from the Fair. By H.	2, 3
"Poldi" Steel.	3
Annual Report of the Chief of the Bureau of Steam Engineering	3, 4
Self-feeding Rip Saw Table	4
An Ignorant Captain	4
The Effects on the Diagrams of Different Pipe Connections to Indicator. By Edward J. Willis, M. E.	5
Says Joshua Rose is Not a Plagiarist—Mr. Durfee Misinformed	5, 6
The Stability of Our New War Vessels	6
Letters from Practical Men: Grinding Lathe and Planer Tools—A Machine Shop "Hold Back." By A Mechanic ... Tidal Powers. By C. L. Redfield	7
A New Friction Driven Drill	7
The Planer at the Charleston Navy Yard	7
American Fine Tools in England	8
Awards	8
An Addition to the Literature of the Steam Engine Indicator	8
Electric Motors for Elevated Roads	8
Two $2-a-Day Men	8
Literary Notes	9
Questions and Answers	9
Society of Naval Architects and Marine Engineers	9, 10
Rail Joints in General—Welded Ones in Particular. By Prof. Joseph Torrey	10, 11
The Motive Power Will Stay at the Head of the Train	11
Information at the Fair	11
The Ethics of Trusts	11
The Fastest Vessel in Her Majesty's Navy	11, 12
Manufactures	12
Machinists' Supplies and Iron	13

American Fine Tools in England.

We hope it will not be considered out of place for us to felicitate ourselves a little upon the following passage which occurs in a description by *Engineering* (London) of the plant of the Auto Machinery Company, of Coventry, a district in which much fine work on clocks, watches, bicycles, etc., is done, and in which American machine tools have within the past few years made a market for themselves on their merits. The passage referred to is as follows:

"An important part of the works—perhaps the most important—is the tool-room, for it is on the accuracy of the machines that the work produced depends. The Auto Company make all their own machine tools—*i. e.*, all used in the production of balls—and in this department they have some very beautiful machine tools, such as lathes, planing machines, etc.; many of these are American productions, some of them very costly tools, but the additional price, we are told, is more than compensated for by the accuracy of the machines, and, therefore, the perfection of work they turn out. This is a statement we hear more often than is pleasant in connection with the finer kinds of machine tools that come from the United States. It is a matter that English machine tool makers might well turn their attention to."

Awards.

It is, we believe, coming to be very generally recognized that little or no importance should be attached to the fact that an exhibitor at Chicago did or did not receive a medal or an award. It seems reasonably certain that nearly every one that exhibited will receive a medal, and what the significance of this medal may be or what it represents in any given case can be determined only by a careful examination of the diploma which accompanies it; a careful comparison of this with every other diploma awarded to a similar exhibit being among the probable necessities in nearly every case before an intelligent opinion can be arrived at as to what the judge or judges really thought of a given exhibit, and even after this opinion or probable opinion of the judges has been ascertained, the question then arises as to the value of this opinion in any given case. There are plenty of incidents related by exhibitors that throw some light on this matter, it being undeniable that judges, in some cases at least, made only very hasty and cursory inspections of exhibits, and while doing so gave evidence of knowing so little of the matter under consideration as to make it morally certain that their opinion was worth just nothing at all. We adhere to our previously expressed opinion that the award that counts is that given by the visitors, and that was secured by showing them something worth seeing and remembering.

An Addition to the Literature of the Steam Engine Indicator.

Elsewhere in this issue we publish an article by Mr. Willis to which we invite especial attention as a most interesting and important addition to the literature of the steam engine indicator. It seems strange that the influence of moderately long and tortuous pipes on the indicator diagram should have remained unsettled so long. Or perhaps it is better to say it seems strange that the verdict should have been so unanimous against every additional inch of pipe beyond the shortest nipple necessary to make the connection, and this without any exact knowledge on the subject. It was the easiest thing in the world to reason out the damaging effect of long pipes, elbows, and the like. Such reasoning was abundantly backed by hypotheses, but the trouble was that something was assumed as a fact that a simple experiment proves to be nothing of the kind. Mr. Willis has once again demonstrated that one carefully conducted experiment is worth more than all the hypotheses that can be applied to almost any given case.

Engineers will thank him for the pains he has taken to make his test conclusive. It is the evidence of extreme painstaking—something that is so often lacking in experimental work—that makes this test valuable.

In the light of this experiment, engineers may place an indicator midway between the ends of the cylinder, with the knowledge that they will get practically correct diagrams. The added length of pipe will very slightly increase the clearance and add a trifle to condensing surface, but unless the cylinder is quite small, this will not be worth very serious consideration. We are glad to be able to present the facts as shown by Mr. Willis.

Electric Motors for Elevated Roads.

The Intramural electric railroad operated within the World's Fair grounds at Chicago during the past summer is furnishing proof that in considering the equipment of an elevated line of road such as some of the new roads in the city of Chicago, electric motors must be at least carefully considered. There is no other road that seems as well adapted to bring out all the strong points of the electric motor as one that is elevated above the streets as these are, where the roadway is sure to be used for no other purpose than the running of trains, where the distances are short, and the noise, smoke, steam, etc., of the locomotive objectionable, especially when portrayed before a jury in a damage suit by abutting property owners, who are in reality to be enriched by the development of the city consequent upon the building of the road.

If the Intramural road has done nothing more it has at least shown that it will not do to ignore its attainments, especially in view of the certain improvement which can be made in future roads based upon experience with this one. The conditions on an elevated road within a city are radically different from those of a trunk line road such as are now, and in our opinion will for a long time be operated by steam locomotives of the present type.

Two $2-a-Day Men.

"Two men are busy at or near a suburban railroad station, separated in their labor only by the width of the tracks and yard. One is an Italian who can speak but little English, and is employed in shoveling coal into the carts of a local dealer. He works nine hours a day, after which time he is his own master.

"The other man is an American He is an intelligent man, an experienced telegraph operator, and is station agent. Sixty or seventy passenger trains stop at the station daily, and nearly a hundred more pass it without stopping. He is responsible for reporting by telegraph the time of passage of every train and for all train orders delivered at his station. In the course of a year he handles very nearly $40,000 in cash, and is charged for the tickets in his rack, and gives bonds for the faithful performance of his duty. He keeps a cash account, looks after freight bills and way bills, makes a daily record of freight cars left at his station, which is a junction point, giving their number and the lines that own them, their destination, hour of arrival and departure, in his care. He is expected to see that the station is kept neat and clean, and inspects the switches. Moreover, he is responsible for the fidelity and activity of one signal man and a gate tender. He works part of Sunday and on week days may be called as late as 11.40 P. M.

"He and the Italian coal shoveler are each paid $2 a day. And yet we wonder at the number of railroad accidents due to the mistakes of station agents and telegraph operators."

The above extract from the Boston *Evening Transcript* affords much food for thought, but one point liable to be overlooked is the fact that the station agent really gets something more than $2 per day, because he has the chance of advancement, either with the company he is now with or with another one to whose service he may bring valuable experience gained in his present occupation. Station agents frequently go into business in the towns in which they are employed, and are successful; their extended acquaintance with men and with business procedure enabling them to start under favorable circumstances.

The coal shoveler has no such prospects. He can shovel coal as well at the end of the first week as he ever can, and his employment affords absolutely no prospect of a material betterment of his condition. We are not in favor of underpaid men in positions of responsibility, but any candid man must acknowledge that the station agent's position holds out much the greatest inducements, and ought to attract men at least better able to discharge its responsibilities than those attracted to the place of the coal shoveler. In the first-named position we should expect to find a man who had not only previously possessed sufficient ambition and intelligence to acquire the education demanded, but also an ambition to rise, while the coal shoveler will usually be a man who is mentally lazy and devoid of ambition. More may properly be expected of the first-named man, and if he is not capable of rendering it he will soon be looking for a job of shoveling coal, where, in most cases, he will not get $2 per day, but will get nothing else than the money paid him, whatever its amount may be.

There is no blinking the plain fact that men in seeking positions will consider the relative chances for advancement, and that this consideration will affect the relative competition for places.

At the same time there are employers who seek to lay too much stress upon this matter of "chance for advancement," and, unwilling to pay a fair price for work, endeavor to persuade men that present low wages means future advancement—an advancement which never comes, and which is never intended to come.

The Grand Jury of Brooklyn recommends that the electric roads in that city be compelled to adopt safeguards to the end that so many people shall not be killed. The number of lives lost in crossing the track—especially of school children—has been alarmingly great, and a part of this loss, the Grand Jury think, might be avoided if the managers tried very seriously. The speed at which the cars are occasionally run is also condemned, the recommendation being that the companies be held strictly to the speed prescribed by law. We are of the opinion that the speed at which the cars are sometimes run in making up time is responsible for a large proportion of the loss of life, and this is something that the city will find it hard to control. Ten miles per hour is the limit of speed according to city law, but if a car is occasionally run at fifteen miles, it will be found a difficult matter to prove the fact. It could be come at readily enough if some suitably devised and accurate speed indicator was suitably arranged in every car, but this, of course, the railway companies will not do unless compelled by law.

A recent instance of an opportunity for the general public to acquire some idea of the responsibilities of marine engineers was afforded by the burning of the steamer "City of Alexandria" at sea. When the fire broke out, following a mysterious explosion among the cargo, and it was found impossible to control it, the nearest point of land was fifteen miles away, and the steamer was headed for this at top speed and beached; Chief Engineer Lynch sticking to his post until the grating of the keel upon the beach told him his work was accomplished, by which time his clothing was scorched and blackened by the fire, and he did not tarry even to shut off steam. The press report mentions no other of the engineer force on the vessel, but we venture to guess that Engineer Lynch was not alone during this time.

The beauties of combinations may be more clearly perceived by a contemplation of the recent action of the combination of railroad passenger agents regarding the New York Central's 20-hour Chicago train. This train proved very popular with those who, for any reason, wished to go from one city to the other without losing an entire day, and the road, it is understood, would have preferred to continue the train as a permanent feature of its passenger service, but the other roads seemed able to have something to say in the matter, and they decided that this train must be withdrawn, presumably because it would not be profitable or would be impracticable for these other roads to run similar trains. Thus we are deprived of this demonstrably attainable result of improvements in railroad equipment; improvements made by mechanics, who by the discontinuance of these trains are deprived of employment they have fairly demonstrated their right to.

Literary Notes.

POOR'S DIRECTORY OF RAILROAD OFFICIALS 1893. Eighth annual number. Containing lists of the officers of all railways in North America and of the leading organizations auxiliary to the railway system; lists of all officers of South American and Hawaiian railways, etc.

The scope of this work has been enlarged, and shows careful compilation. One of the new features introduced in this book is a classified index to the leading manufacturers of railway appliances; this index seems to be very complete, and certainly forms a comprehensive buyers' guide. A list of officers of 987 steam railroads is given, including about 10,500 names carefully catalogued according to location; and another list of the same officers indexed alphabetically; these lists will be found to be very convenient for the location or identification of any official. The book also contains a statement showing by States and groups of States the mileage of all street railroads in the United States and Canada in 1891 and 1892. The total length of these lines in the United States is now 10,769.82 miles, an increase of 1,107.76 miles over those presented in the last edition of the directory, the increase being distributed as follows: 101.70 miles in the New England States, 144.35 miles in the Middle Atlantic States, 290.82 miles in the Central Northern States, 69.41 miles in the South Atlantic States, 48.80 miles in the Gulf and Mississippi Valley States, 160.80 miles in the Southwestern States, 83.22 miles in Northwestern States, and 208.66 miles in the Pacific States.

The new features of this work and the enlargement of its scope enhance its value. Those who have any commercial intercourse with railroads, and those who wish to arrive at the most important facts pertaining to such, cannot do better than to procure a copy of this directory, which can be obtained from its publishers, H. V. & H. W. Poor, No. 70 Wall street, New York. Price per copy, in cloth, $3, and $2 per copy in paper.

Questions and Answers.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet.

(567) A. W. K., Cleveland, O., writes: Kindly inform me, when or about when the first sheet of hot metal was pressed into any article of use, such as the steel pressed car wheels, center plate, corner bands, stake pocket, etc. *A.*—We cannot answer this question with any degree of certainty of being correct, and it is doubtful if reliable information in regard to this matter can be obtained.

(568) S. M. H., Newark, N. J., writes: I have trouble to keep my air pumps packed. I have heard of wood packing. Can you give me any information and sketch of the same? *A.*—We presume you refer to air pumps for condensing engines. Wood packing has been used in pumps of this kind, but proved to be very unsatisfactory. We should not advise you to use wood packing for this purpose. You should have no trouble with hemp packing if properly put in place.

(569) F. M., Schenectady, N. Y., asks: Can you send me a list of questions which applicants for a stationary engineer's license will have to answer? *A.*—There are no regular set of questions asked, but if you can answer all the questions (many of which are likely to be asked) published in our issues of April 25, June 27, August 22, 1885, and January 30, 1886, you will undoubtedly be able to pass a creditable examination. We can furnish you with any or all of these numbers at any time you may send for them.

(570) H. J. K., Litchfield, Minn., writes: We have here a 75 horse-power engine built to run at 200 revolutions, but in order to get speed enough for the dynamos, it is speeded up to 260 revolutions. The foundation is giving away, and the high speed seems to rack the engine. Would it be advisable to put a 68 inch pulley alongside the 60 inch fly-wheel, and run at 200 revolutions? *A.*—If you will get power enough by so doing, it would probably be better to run the engine at the speed for which it was built. If, as we assume, you are now belting from the 60 inch fly-wheel, and desire to keep the dynamos at their present speed, the pulley should be 78 inches instead of 68 inches.

(571) T. F., Montreal, Canada, writes: Kindly inform me of the best way of cleaning brass wire cloth that has a black scale over it. I want it to look like new. If you know of any liquid, I would prefer it to a paste, as it must be in every way free from being clogged after the process. *A.*—The solution for cleaning the brass cloth depends much on the nature of the scale. On general principles we should try the following: Wash with or scrub with soda, or potash water, or lye. Then dip in a solution of 1 ounce sulphuric acid, ¾ ounce nitric acid, ½ drachm saltpeter, and 1 ounce of rain water. Allow this solution to repose a few hours before using. Pass the cloth to be cleaned rapidly through the solution, and immediately wash it thoroughly with rain water, and then dry it.

(572) E. G. K., Plainfield, N. J., writes: Kindly answer the following questions: What should be the diameter of a running cable for carrying a load of 6,000 pounds; the distance between supports is 300 feet; also what should be the diameter when this distance is reduced to 100 feet? What deflection would you allow in making the computation, and would you advise the use of a cable with hemp center or iron center? *A.*—The diameter of the wire rope will depend on the deflection which may be allowed, and this again depends on the purpose for which the rope is to be used, and the working conditions of which you have said nothing. For a deflection of 50 feet, with supports 300 feet apart, you will need a wire rope, if made of iron, 1¼ inches diameter; for a deflection of 25 feet, with 300 feet between supports the diameter will have to be increased to 1⅝ inches. With a distance of 100 feet between supports, and a deflection of 17 feet, the diameter of the rope will also have to be 1⅝ inches, and with a deflection of 25 feet the diameter may be decreased to ¾ inch. We prefer a rope in which the wire strands are laid around a hemp center. 2. Please refer me to any reliable literature on wire rope haulage. *A.*—"Mechanics of Engineering and of Machinery," by J. Weisbach, volume 3, part 1, section 2. This work is published by John Wiley & Sons, 53 East Tenth street, New York.

(573) E. M. C., ——, writes: A. invents a machine, and as there must be considerable experimenting on it he assigns three-quarter interest in the invention to B., C. and D. (one quarter to each), he receiving a regular salary from them and retaining one-quarter interest in the patent. The machine proves to be a success, two of them are built and the patents are granted. A., the inventor, and D., the managing partner, have a falling out and D. refuses to have anything more to do with A. or with the patent. D. has a business "pull" with B. and C. which prevents them from doing anything contrary to his wishes, and he has both the machines stored away on his premises, refusing to give them up or to exhibit them. 1. Can A. manufacture and sell these machines without the consent of the others? *A.*—If the assignment contains no special clause which prevents, he can. That is to say, if the assignment is simply one-quarter undivided interest in the patent without special limitations, either one of the owners can manufacture and sell the machines without accounting to the others, all being on an equal footing in this respect so far as the rights granted under the patent are concerned. 2. Will he have to pay them a royalty? *A.*—Not unless the terms of the assignment or some special agreement requires him to do so. 3. Can he compel D. to give up the whole or a part of the property in his possession? *A.*—If the terms or agreement under which the machines were built were such that A. actually owns one-quarter interest in them, he can compel D. to give up the property or pay the value of his interest. This would be a question for lawyers or a court to decide, and would be independent of the patent. It is simply a question of property rights regardless of the patent. 4. If A. can buy B.'s or C.'s interest, thus giving him one half interest, will he be any better off? *A.*—He will have no greater or better right to manufacture and sell. He will simply have acquired one other man's equal right to manufacture and sell under the patent, which may be worth much or nothing, depending upon circumstances. 5. Has the inventor, owning a part interest, any rights which an assignee, owning an equal interest, does not have? *A.*—No.

(574) J. D., Streator, Ill., asks: What is the proper thickness for each side of an eccentric piston ring, say for a 4 inch cylinder? Give rule for finding the same, and for finding the width of the ring. *A.*—In a case of this kind we first find the dimensions of a ring of uniform cross-section throughout. The thickness of such a ring made of cast-iron should be $\frac{1}{30}$th of the diameter of the cylinder + ⅛ inch, this will give us for a 4-inch cylinder a thickness of $\frac{4}{30} + \frac{1}{8} = .258$ inch, say ¼ inch. The width of the ring should be equal to the thickness + ¼ inch, hence the width will be ⅝ inch. For an eccentric piston ring the sum of the minimum and maximum thicknesses should be equal to twice the thickness as found above, and the minimum thickness should be about ⅞ of the maximum, hence the latter thickness should be .3 of an inch, and the former .2 of an inch. These rules are of course arbitrary, but in our practice we have found them to give satisfactory results. Nearly all steam engine builders have their own rules, and, as might be expected, the dimensions of the piston rings vary. It may also be mentioned that with the use of eccentric piston rings we have not obtained more satisfactory results than by the use of rings of uniform cross-section throughout, and therefore prefer the latter. 2. In your issue of May 4, current volume, you give a description of the "Waterspout" pulsating steam pump, and you say that a vacuum is formed by the steam coming in violent contact with the water, and thus the steam valve is sucked over. Is not this a mistake? for how can there be any vacuum formed as long as the chamber is open to the boiler? *A.*—What we did say in the description is this: "As soon as the level of the water is as low as the bottom of the inclined partition (below which the water passes to the delivery chamber) the steam rushes through with a certain amount of agitation, producing instantaneous condensation, through being brought into violent contact with the water. The vacuum thus formed, etc." When the steam enters the chamber which is nearly filled with water, the steam remains in a comparatively quiet state during the time it is forcing the water out, until the opening into the delivery chamber is reached, then the water and steam become more or less agitated causing the two to mix and producing condensation. This of course must reduce the pressure in the chamber to that below the atmospheric pressure, or in other words, causing a partial vacuum, on the same principle which causes a partial vacuum to form in a jet condenser when the exhaust steam comes in contact with the sprays of water. We see no mistake in the description.

(575) G. B. S., Buffalo, N. Y., writes: I have a 10 inch turbine wheel which is to work under a head of 45 feet and be supplied through a pipe 600 feet long. Please inform me what diameter of pipe will be required. *A.*—We referred this question to Mr. W. Cox, who replies as follows: A 10 inch turbine wheel may discharge anywhere from 260 to 660 cubic feet per minute under a 45 foot head, the exact quantity depending upon the "vent" of the particular wheel in question. Before fixing upon a suitable diameter of pipe, we must know the velocity of flow of the water in the pipe. Let us assume a velocity of 3 feet per second, which is a fair rate. We then have, (1) to discharge 260 cubic feet:

$$\text{Area of pipe} = \frac{\text{Discharge} \times 144}{\text{Velocity} \times 60} = \frac{260 \times 144}{3 \times 60}$$

= 208 square inches, whence diameter = 16¼ inches. (2) To discharge 660 cubic feet:

$$\text{Area pipe} = \frac{660 \times 144}{3 \times 60} = 528 \text{ square}$$

inches, whence diameter = 26 inches. We now require to find the loss of head by friction for 16 and 26 inch pipes, 600 feet long, with 45 feet head. We have, therefore, by Cox's formula:

$$\text{Loss of head} = \frac{\text{Length}}{1{,}200 \times \text{diam.}} \times (4\ V^2 + 5\ V - 2) = \frac{600}{1{,}200 \times 16} \times (36 + 15 - 2)$$

$$= \frac{600 \times 49}{1{,}200 \times 16} = \text{say } 1\tfrac{1}{2} \text{ feet,}$$

so that the effective head is reduced to 43½ feet.

Again,

$$\text{Loss of head} = \frac{600 \times 49}{1{,}200 \times 26} = \text{about 1 foot,}$$

the effective head being reduced to 44 feet. The loss upon a fall of 44 feet is therefore very slight. It is calculated for smooth cast iron pipes. If riveted pipes are used 25 per cent. more loss should be taken into account. A smaller diameter of pipe might probably be used just as well, in which case the velocity and the friction head would be greater; thus, suppose we take a 22-inch pipe, we have for 660 cubic feet discharge:

$$\text{Velocity} = \frac{144 \times \text{Discharge}}{60 \times \text{Area}} = \frac{144 \times 660}{60 \times 380} = 4.2 \text{ feet per second.}$$

This would give us for loss of head:

$$\text{Loss of head} = \frac{600 \times 89}{1{,}200 \times 22} = 2 \text{ feet.}$$

Nothing definite, however, can be recommended unless the make of wheel, or at least the quantity of water it will discharge, is known, as upon this depends the diameter as well as the horse-power obtainable, but we think a 22 inch pipe would be very suitable. If a good wheel is then used, something like 40 horse-power should be obtainable. If G. B. S. will send us further particulars, we will examine his query again. All such problems are most easily solved by means of "Cox's Pipe Computer," which is used by all the leading turbine makers.

Business Specials

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Grant's Gears, Lex'n, Mass., & Phila., Pa. See p. 12.

Forming Lathes Mer. Mach. Tool Co., Meriden, Ct.

6-Spindle Turret Drills. A. & Quint, Hartford, Ct.

Milling Machs. Kempsmith M. T. Co., Mill., Wis.

Pattern and Brand Letters. A variety of sizes and styles. Heber Wells, 8 Spruce St., New York.

Davis Key Seating Machines kept in stock by Manning, Maxwell & Moore, 111 Liberty St., N. Y.

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt St., N. Y.

Pulley lathes, most efficient offered. The Lodge & Shipley Machine Tool Co., Cincinnati, O.

Air Compressors for every possible duty. Clayton Air Compressor Works, 43 Dey Street, N. Y.

Steam Pressure Regulators, Reducing Valves, Safety Checks, Foster Engineer'g Co., Newark, N. J.

For the best and cheapest packing rings, address J. H. Dunbar, Youngstown, Ohio.

Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.

Split Pulleys at low prices, and of same strength and appearance as Whole Pulleys. Yocum & Son's Shafting Works. Drinker St., Philadelphia, Pa.

Most sensitive and durable Damper Regulator made; works within one pound. Send for circular. T. Kieley, 11 W. Thirteenth Street, New York.

Improved Duplex and Special Gear Cutters in stock and to order; Gear and Milling Cutters of all descriptions. R. M. Clough, Tolland, Conn.

"Pumping Machinery." New book, 450 pp. 8vo, 270 Eng. Prospectus free. W. M. Barr, 3223 Powelton Avenue, Philadelphia, Pa.

New Jersey Art Metal Co., Passaic, N. J., finest thin and ornamental castings in brass, bronze, aluminum, etc; machinery name plates in brass and aluminum.

"Binders" for the AMERICAN MACHINIST. Two styles, the "Common Sense," as heretofore sold by us and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUBLISHING CO. 203 Broadway, New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram, also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price, $2 postpaid. Published by John Wiley & Sons, 53 East Tenth Street, New York.

Society of Naval Architects and Marine Engineers.

The first general meeting of the Society of Naval Architects and Marine Engineers took place in New York City during Thursday and Friday, 16th and 17th inst. Through the courtesy of the president and managers of the American Society of Mechanical Engineers, the meetings were held in the rooms of that society, No. 12 West 31st street. The first meeting was held under very satisfactory auspices. Although this society is not yet one year old, it has an enrolled membership of 435, including engineers and naval architects of high rank and some of the most prominent and influential men in the shipbuilding and shipping interest of the United States. Its treasury, too, is in a very healthy condition. The following officers were elected for the ensuing year:

President, Clement A. Griscom, of Philadelphia, President International Navigation Company; 1st Vice President, Theodore D. Wilson, of Washington, D. C., Chief Constructor United States Navy; Vice-Presidents, Chas. H. Cramp, of Philadelphia, President Wm. Cramp & Sons' Ship and Engine Building Company; George W. Melville, of Washington, D. C., Engineer-in-Chief United States Navy; Geo. W. Quintard, of New York, President Quintard Iron Works; C. H. Loring, of New York, Ex-Engineer-in-Chief United States Navy; Irving M. Scott, of San Francisco, Vice-President and General Manager Union Iron Works; Francis A. Walker, of Boston, President Massachusetts Institute of Technology; Wm. H. Webb, of New York, Naval Architect (retired); Commodore R. W. Meade; Philip Hichborn, Naval Constructor, United States Navy; Sec. & Treas., Washington L. Capps, of Washington, D. C., Assistant Naval Constructor United States Navy. A society starting under such flattering circumstances promises to have a great influence on, and will do much towards the advancement of knowledge and the successful solution of many knotty problems in these particular branches.

The first paper, a valuable one, "Evolution of the Atlantic Greyhound," was presented by C. H. Cramp.

The second paper was read by Joseph J. Woodward, Naval Constructor U. S. N.; it dealt with the "Determination of the Approximate Dimensions of a Vessel to Fulfill a Given Programme of Requirements." It is very technical in character, and will undoubtedly be highly appreciated by naval architects. The third paper related to the "United States Treasury Rules for the Inspection of Machinery and Boilers," by James T. Boyd, General Manager George F. Blake Manufacturing Co.

This paper created quite a discussion, but the general drift of opinion seemed to be that no engineering formula should be incorporated into the laws, which should only contain principles, and the details should be left to the engineer.

The fourth paper related to the "Production in the United States of Heavy Steel Engine, Gun and Armor Plate Forgings," by Russell W. Davenport. It is an exceedingly interesting paper and of great value to the engineer.

The fifth paper was read by Albert P. Niblack, Lieutenant U. S. Navy. It relates to "Coal Bunkers and Coaling Ships."

The second day's session of the inaugural meeting opened with a discussion on the paper on "Coal Bunkers and Coaling Ships," read on the day before.

The remedies suggested by the author of the paper were criticised by some of the members, but all seemed to agree that this subject requires careful attention, and the general ideas were commended.

The next paper, which treated on "Steel Ships of the United States Navy," by ex-Chief Constructor Theodore D. Wilson, and the paper directly following it by Commodore Geo. W. Melville, Engineer-in-Chief, U. S. N., on "Notes on the Machinery of the Vessels of the U. S. N.," are exceedingly interesting, instructive and valuable contributions. We regret that the copyright of these papers prevents us from giving them in full.

The other papers read were "Comparative Performance of American and Foreign Freighting Ships—Our Superiority," by William W. Bates, late Commissioner of Navigation, U. S., Treasury Department; "Some Thoughts on the Design of New York Ferry Boats," by Col. E. A. Stevens; "On the Law of Frictional Resistance," by Prof. W. T. Durand; "The Steam Yacht as a Naval Auxiliary in Time of War;" "The Influence of Speed and Weight of Machinery on the Determination of the Other Elements of Design of Steam Vessels," by James J. O'Neill; "The Wetted Surface of Ships," By D. W. Taylor, Naval Constructor, U. S. N.

During the session, William H. Webb, the veteran ship builder, invited the members to visit the institution which he has just opened at Fordham Heights, in which instruction in shipbuilding is given to young men.

Rail Joints in General—Welded Ones in Particular.

BY PROF. JOSEPH TORREY.

The most serious problems in engineering rise from the fact that very few institutions remain as they are started. All of them undergo some change. Sometimes it is a mere growth in size and extent, but more frequently it involves more or less complete change of base. Moreover this is not ordinarily a process that takes place uniformly. It is, like every process of evolution, subject to periods of rapid change, as well as periods of comparative stagnation.

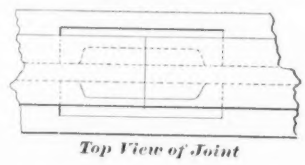
The history of American railroads is a striking case in point. It has been characterized by most marvelous growth and development, and has evolved, by the number and complication of its problems, a collection of engineers and a set of engineering achievements which it would be hard to parallel elsewhere.

Most of the above mentioned problems owe their origin to the fact that as the demands or the new means of travel increased, heavier trains and consequently heavier locomotives were needed, and, of course, were at once forthcoming to meet the demand. This necessitated a rebuilding and strengthening of road beds, and an increased amount of attention to the quality of material employed for this purpose. This is exactly as we find it now. We have reached no resting place. Meanwhile the street railroad problem has come up. The horse car has had a long reign, and the tracks have been laid in much the same way ever since the first. There has been, of course, a little done in the way of making tracks a little smoother, but in general there has been a long period of stagnation. Now the horse car is fast disappearing, and the cable and trolley are furnishing us means for moving much heavier cars much faster than we have been able to before. The result is that the demands on the street railroad tracks are daily becoming more exacting, and the problems which have so long confronted the railroad engineer now loom up before the street railroad men, and in some cases the questions to be dealt with are more serious ones in the latter case than in the former. Take, for instance, the question of rail joints. It is a much more serious question in a street than on the steam railroad. To be sure the actual tonnage is in general greater on the latter, though not so much greater as one would think, but the fickle and ever-changing street, which is a poor place for a track any way, complicates the situation immensely. Let us first look at the question of actual wear and tear. The greater part of the closed cars on the electric lines in Boston and suburbs weigh, I am informed, about 25 tons. When loaded, as they often are, they are about 4 tons heavier. They have rather small wheels, and the rail joints, though made with considerable care, cause quite a thump. This thump is very destructive, of course, and grows worse as the joint gets more distorted by the constant hammering. Moreover, since the top of the rail must be flush with the pavement, or nearly so, the joints cannot be so readily inspected as those on the steam railroad, and the whole track system is much more rigid, laterally, than is the steam railroad track. This is a very important point, and must always be kept in mind in designing rail joints for street railways. In general, however, the same underlying principles hold in both cases.

I have no intention of reviewing here the vast number of joints that have, at various times, been proposed and actually used. My object is to call attention to a recent experiment in this direction, and to discuss briefly its possibilities. At present I am rather inclined to judge it unfavorably, but am entirely open to conviction, and any one who feels inclined to quarrel with the conclusions expressed only needs to meet facts with facts.

The idea of welding rails at the joints is not by any means new. It is almost as old as the railroad itself, and all our text-books of physics for years have warned us against the sad results of not providing room for expansion and contraction in this case. There has been no real opportunity to try the experiment till lately any way, for obvious reasons. Electric welding has made it possible to do the mere mechanical part with comparative ease, and lately it has been tried. I have seen its operation in one place only, and what I say is based solely on what was seen there.

First as to the method. The rail ends are not butted directly together and then welded. The ends are brought well together or thin sections of rail are put in if necessary, so as to make a nearly continuous surface. Then two steel blocks, with off sets at the ends, are placed as shown in the figure. These blocks are, I should say,



Top View of Joint

about 7 inches long, and perhaps $4\frac{1}{2}$ or 5 inches wide and 1 inch thick. These dimensions are not exact but near enough. The blocks having been placed in position, a special car, having on it the dynamo and other appliances, is brought up, and the joint is firmly grasped by a large toggle joint press, which is carried on a crane at the end of said car and through whose jaws the current is allowed to pass at the proper time. I ought to have said that the portion of the rail where the weld is to be made is cleaned by an emery wheel fixed to the end of a flexible shaft and operated by current from the trolley wire. Everything being in place, the tremendous current is turned on, and the joint speedily begins to heat up, and in two minutes is at a bright red heat. From time to time the jaws of the press must be closed in a little to maintain perfect contact. The joint grows rapidly hotter and hotter, and in a very few minutes is at a good welding heat. The jaws (which close in by the operation of a large hand-wheel) are then rapidly closed in so as to finish the weld and the work is over.

Now as to the results. In the first place there has been, so far as I have seen, a decided tendency to breakages. The weld does not break, but the rail often does. The break is usually less than a foot from the weld, and when it takes place the iron springs apart about $\frac{8}{32}$ inch or from $\frac{1}{16}$ inch to the amount just given. It will readily be seen that this points to no insignificant strain. The usual practice in such a case seems to be to simply weld the break just as the joint itself was welded. As to the number of such breaks, I counted in less than $\frac{3}{4}$ mile of *double* track 28 breaks. Some of these I know about personally; others I am only able to speak of from testimony. Most of them occurred with the passing of the first car after the weld was made. Others broke with a little more difficulty. I have no reason to believe that the portion of the track I examined—and where most of my observations have been made—is a particularly bad one. The general testimony as I have been able to gather it is that breaks are, on this piece of work at least, quite frequent; and yet I have heard the rumor that in other places the system has proved itself successful. It is certainly impossible to judge it yet completely in the place I am speaking of.

Since, however, the subject has opened up it will do no harm to look the results in the face and see whether they are in accordance with what is to be expected or not, and whether the idea appears off-hand to be in the line of sound engineering.

It is, I suppose, well known to every one that it is not necessarily true that expansion and contraction will ruin a continuously laid railroad track. There are cases on record where several miles of railroad track continuously laid have shown no sign of bad effects from expansion or contraction. This fact seems to me to find a partial explanation in the lateral freedom of the track. Considerable lengths of steam pipe will take care of themselves if there are bends where the motion of the pipe is comparatively free. But do these conditions exist in the street railroad track? I think not. In the first place most of the curves are short ones, and for obvious mechanical reasons the track does not as easily distribute its tensile strains as it does with longer and more gradual curves. Then again the track is much more rigid, laterally, than in the steam railroad. On this point there may be room for difference of opinion. It seems to me, however, that even in case of a rock-ballasted road-bed, the street, made almost entirely of rock itself to begin with, hammered hard as iron by incessant and heavy teaming and reinforced by solid paving, is incomparably more unyielding. Then again the method of laying the rails differs in the two cases. In the regular railroad the ties, although bedded in sand, have a certain freedom of motion. In the street railroad, on the contrary, the rails are laid on stringers and fastened to them very firmly. When such a system is walled into its bed of road metal and pavement its lateral freedom can only be very small indeed. It may be that the importance of these considerations is exaggerated, but I think not. If we find a certain disturbing force apparently not resulting in strain it is certain that the structure must either have the power of accommodation, that is to say, of moving as a whole in the direction of the strain, or else must be elastic enough or loose enough somewhere so that the strains are dissipated.

There is one more point worth considering. The weakest point in a rail is the end. It has in some cases the odds against it to begin with from its very history. Crop ends are cut from ingots after the first rolling into billets, but a crop end spreads and flows as the ingot is rolled differently in different ingots and when the billet goes on to the finishing rolls the rails rolled from it need to be trimmed at the ends also. This is always done, but the amount necessary to cut off from a rail is not constant. It depends somewhat on the heat of rolling, and from what I have seen of the process, I am inclined to think that in some cases the trimming may be insufficient. Then again the end of the rail, as before stated, has to take the most severe shocks of any part, and any bad effect which is to be produced by repeated and violent shocks has its best field there. The rails which have been furnished for street railways are presumably not equal in quality to those employed on regular railroads.

Considering all this, I can see no reason to think the behavior of the welded joints as I have seen them is anything accidental or abnormal, and moreover it seems reasonable to expect that when winter comes there will be some more breaks.

In some cases it may be the joint cooled too quickly. There was a tendency toward the latter part of the work to bury the joint in sand as soon as welded, and let it cool slowly. It may be also that cars passed too soon, and that the blow of the car truck came while the metal was in a particularly unsettled state. Further, it may be that short lengths (a mile or so) of track cannot distribute the strains, but that a greater length would, and perhaps when the whole system is welded it may take care of itself. But after all, when we have made all due allowance for these and other possibilities, the fact seems to remain that we have a terribly inflexible system in which to put such strains in play.

But even if the track will behave itself, the question still remains whether it is good engineering. It looks to a layman as if a well-made fish-joint properly placed, *i. e.*, *suspended*, not supported, would be as good and more manageable. Moreover the welding of the joints looks as if surface street tracks were permanent things, which does not appear to be the case. The same is true of the heavy rails which are now being put in. If any change is made in street rolling stock, it will probably be in the direction of lightness.

Finally, I have so far been unable to see

any ruling reason why welded joints should be better than well-made ordinary ones. In any track system whatever, the principal difficulty in securing good joints comes in the instability of the road-bed. There is no rail joint fastening in the world that will stand service on an insecure and shifting foundation. Moreover, I believe it to be true that no rail joint yet made will stand service when solidly and rigidly supported I can see no reason why a welded joint is not going to wear and "broom" as well as any other. The thump of the cars as they pass the joints is, so far as I can see, about as severe as ever, and it seems to me that when wear does take place it will be harder to get at and replace rails.

I know it is commonly considered good form to assume that people know what they are about, especially when it comes to a matter of out and out dollars and cents. I have no doubt that welding is in process of trial, because it has shown good prospect of successful and economical operation. At the same time it does not always follow that because a thing is started by a large establishment it is good engineering. I know, for instance, of a large and experienced firm getting out an extensive line of machinery for a certain purpose recently. To-day that machinery is in scrap heaps all the way from here to Colorado, cause—poor mechanical engineering, nothing else. Other cases history will produce in quantity. Sam Weller's remark is, to a certain extent, a pertinent one in engineering. "Werry good thing is weal pie when you know the lady as made it."

The Motive Power Will Stay at the Head of the Train.

It is somewhat amusing to read the editorials and comments upon the tug of war which occurred on Railroad Day at the Fair, between an electric motor and a steam locomotive. The steam locomotive came out victor, not because it was operated by steam, but simply because it weighed more than its competitor. The locomotive was a Baltimore & Ohio switcher, weighing 65 800 pounds on the drivers, and the electric locomotive, made by the General Electric Company, weighed about 60,000 pounds. As both engines could slip their wheels, the result could only go one way—the heavier one would pull the lighter—but the incident has afforded a text for many editorials eulogizing the steam locomotive, and prophesying that it will be many a long day before it is superseded by the electric locomotive. These prophecies may be true, and doubtless are, but the tug of war has no bearing on the matter.

One of the editorials referred to appeared in the pages of *Locomotive Engineering*, in which the following was stated:

"It appears to us that an electric locomotive is a mistake, anyhow. Those who work on this line of invention attempt to perpetuate the worst feature of a steam locomotive, which is the big percentage of dead weight added to the train. To exert a starting power of 20,000 pounds on the draw-bar a locomotive must weigh over fifty tons. . . . When electricity is employed, the wheels of the cars can easily be made the drivers as in the case of street cars. A train operated in this way would not have a heavy locomotive to be lifted up every hill, and to add nearly as much weight as the remainder of the vehicles. If ever electricity should come into use for the operating of surface roads, we anticipate that every car will carry its own means of applying power. The prospects of seeing electric locomotives in the front of trains are not good."

These remarks are in line with an argument that has been advanced many times, but which is manifestly absurd. It only requires a little calculation and a familiarity with railroad business to know that the only feasible way to employ the present electric motor on surface railroads would be to place it at the head of the train. Take, for instance, the freight traffic of the country. Assume that we have a train of forty cars requiring at its head a steam locomotive of eight hundred horse power weighing fifty tons, and with its tender eighty tons. We have twenty horse power available for each car, excluding the engine itself, and if each freight car was fitted with a twenty horse-power electric motor, provided with heavy axles, wheels, gearing and appurtenances, it would require fully three thousand pounds additional weight per car. This means sixty tons weight embodied in motive power in the train, and is actually more than would be required if concentrated in one motor at the head of the train, and is more than the weight of the steam locomotive exclusive of tender. So the idea of saving weight by such methods is erroneous, for putting motors on each car would not enable us to lighten the construction of the cars in any respect, and, as has been shown, the total weight added to the train would be more than if concentrated at the head of it.

Then small motors cost much more per horse-power than large ones, and are less efficient. Another fact which is apparently given no consideration is that the average freight car makes about twenty-four miles per day, or say, eight thousand five hundred miles per year, while the steam locomotives can easily make fifty thousand miles a year; therefore, to put motors under the cars would not only involve a larger expenditure of capital per horse-power and a lower efficiency, but would result in getting only about one sixth as much mileage from the motive power. Then there is all the complication arising from operating all the motors from the front of the train, to say nothing of the fact that repairs would have to be made upon forty machines instead of one, and must invariably be more expensive. The same argument we have here employed is applicable to passenger equipment.

Just think of railroads choosing to buy and maintain over 1,100,000 motors for freight service, and nearly 40,000 for passenger service, when 35,000 larger ones would do the whole business! If ever used at all, the motors will go to the head of the train. —*The Railway Master Mechanic.*

Information at the Fair.

We do not wish to appear as though desiring to continually carp at the Chicago Fair, but the fact is that more is to be learned that will tend to make the next world's fair successful from the shortcomings of the recent one than from its successes, and one of those shortcomings that should not be repeated in any future exhibition was in the matter of facilities for getting information.

Most people go to such an exhibition mainly to learn. An international exhibition is nothing if not educational, and its greatest, if not its only justification, is in the fact that people who desire to increase their stock of knowledge can thereby do so. This being the case, it would seem as though every possible facility should be given for acquiring knowledge respecting exhibits. It is obvious that the best manner of doing this is by attaching to each exhibit a card bearing such information as will at least put the visitor in possession of the leading facts in regard to it, in the shortest possible time, and with the minimum of bother for himself or others.

Where a visitor, in order to find out whether or not an article is worth thorough investigation, has to note its catalogue number, and then find that number in the catalogue before he is in the way of learning anything about it, he will perforce fail to appreciate much that he would be capable of appreciating, and which he ought to be given an opportunity to know all about.

Most of us, for instance, have only a limited knowledge of art matters, and can do very little in the way of appreciating most pictures, and other works of art, unless we know something of the artist, and of the idea he intended to convey. Any one who has tried consulting a catalogue for this information knows that it is tedious work, and, as a matter of fact, few people have either the time or the patience to follow it out. It seems a shame that these people should be deprived of what ought to be one of the best features of the show, because it was thought the proper thing to give to private individuals the franchise for publishing the official catalogue, making it a part of the compact that no information should be given by placards upon exhibits, thus forcing people to either consult catalogues, or go without the desired information. The absurd condition of affairs resulting from this farming out of what should have been entirely under the control of the Exposition management, is best realized perhaps by the fact that those exhibitors who were willing to pay $3 to $4 per line for the privilege, were permitted to give such information as was prompted by commercial considerations, regardless of truth, or of the rights of those who purchased the "official catalogue" for the sake of the information supposed to be contained in it. This lack of facilities for readily gathering information was, like most of the other shortcomings of the Exposition, chargeable to the concessionaire, and the too great power vested in him.

And as regards this matter of information about exhibits, the course pursued by some exhibitors, or those acting for them, was somewhat puzzling. The natural presumption was, of course, that machines—say typesetting machines for instance—were exhibited that they might be seen, and their advantages understood. A man in charge of one of these was asked by a visitor what was done when the wrong key was struck, thereby putting a wrong letter into the cast line of type. The gruff and repellant answer was, "You are not supposed to make a mistake," and it was only by persistent questioning and refusal to be bluffed that the visitor finally got a correct answer to his perfectly proper question. Most visitors, less interested, or less good naturedly persistent, would have given up the attempt, and been cheated out of a positive right purchased at the gate with the ticket of admission. Exposition managements might well retain control of such matters as this, and compel such short-sighted exhibitors to furnish reasonable information respecting their exhibits.

The Ethics of Trusts.

At a recent meeting of stove manufacturers at Chicago, Mr. Lazard Kahn read a paper on "The Stove Industry and the Ethics of Consolidation." The paper seems to consist of a restatement of all the well-known and well-worn arguments in favor of trade combinations, and the statement is made that "It is no palliation [of the deplorable state of the stove trade] to say that among existing manufacturers a number have also made large profits." But the trouble is that most people will insist that this is a palliation, and that so long as the best equipped and best conducted establishments can make a profit at ruling prices, ruling prices are right; the greatest good of the greatest number considered.

After all possible arguments have been presented in favor of trusts or trade combinations, it still remains true that competition is practically the only influence that will impel men to advance and take advantage of every new discovery and improvement that will tend to cheapen or improve production.

It is perfectly clear, for instance, that the modern system of milling in use in the flour mills of this country could not have been introduced had it not been for competition, which forced it into use.

And it is to be remembered that where a trust does not increase the price of what it produces, it at least maintains it, no matter how much the cost of production may be reduced by improvements. This is shown in the recent history of steel rails. Notwithstanding the steadily decreasing cost of production by reason of decline in price of Bessemer pig and introduction of improved machinery for converting it into rails, the price of the latter remained at one figure for years with monotonous persistency; the reason being that manufacturers in this country had a combination that fixed their price where the least efficient mill in the combination could make a profit. This was undoubtedly prejudicial to every other interest and tended directly to the discouragement of new railroad enterprises, and the improvement of others. While this combination was maintained one establishment (Carnegie's) put in every possible improvement for their economical production, and when it appeared that more money was to be made by disregarding the combination, dropped $5 per ton on their price, a reduction speedily followed by still heavier reductions by other mills, and the death of the combination. It is nonsense to say that such a reduction in price of a prime necessity of our modern civilization is "to be regretted," that it "produces demoralization," and "has a tendency to reduce wages." It will cause more rails to be used, and call for more men to make them, the demand for men relative to the supply of them, regulating in the long run the rate of wages, while cheaper rails by stimulating or rather removing an unnatural barrier to railroad development will tend to increase the demand for workmen in other lines and reduce the cost of transportation which is an important element in effective production, thus in effect raising wages. For it makes no difference whether a workman's condition be improved by increase of what is paid him or by decreased price of what he has to buy, the grand and ultimate object of all industrial and social development being not to secure for men a high remuneration stated in dollars and cents, which may mean much or little when compared with what is bought with them, but to increase the power of man to secure those things that satisfy his desires; or in other words to enable him to supply his wants with the least possible labor. Trusts stand directly in the way of this development, and from their nature must always be an impediment to it in proportion to their success measured from the standpoint of those interested in them.

The Fastest Vessel in Her Majesty's Navy.

We have the pleasure to record the successful official trial on Saturday last of H. M. S. "Havock," built by Messrs. Yarrow & Co. This trial was looked forward to with more than usual interest, the "Havock" being the first of twelve similar vessels of an entirely new and distinctive type, which are being built by private contract for the British Admiralty. They have been designed by Mr. W. H. White, Director of Naval Construction, and are intended to be superior to other fast vessels building by foreign powers, who, it is well known, have made great advances of late in the construction of such vessels. The name given to this new type is that of "torpedo boat destroyer." They are intended to act against torpedo boats, and to have a speed superior to that possessed by such craft at the present time, and, what is of the highest importance, to be capable of maintaining that speed at sea, in which torpedo boats have been found to be sadly deficient. Their coal-carrying capacity will enable them to have a radius of action far greater than the present torpedo boats, and to test by practical experience how far the "Havock" can operate from a base, a further slow speed trial is to take place at the end of this week. The "Havock" is called after a famous warship of some hundred years ago, and is 180 feet long by 18 feet 6 inches beam, and about 200 tons displacement. She has two sets of triple-expansion engines, with cylinders 18 inches, 26 inches and 39½ inches in diameter by 26-inch stroke, designed to give 3,500 horse power at 400 revolutions per minute. They drive twin screws, having three manganese bronze blades 6 feet 2 inches in diameter. Her boilers are two in number and of the locomotive type, one to each set of engines, in separate stokeholds, forced

draught being supplied to them by two fans by Allen & Co., and are designed for a working pressure of 180 pounds per square inch. Her guaranteed speed is 26 knots on a continuous run of three hours. This the "Havock" easily exceeded on Saturday, in spite of a very heavy sea—the water finding its way even into the engine room—when she attained a mean speed during the three hours of 26¼ knots, the boilers keeping a plentiful supply of steam with the pressures ranging from 160 pounds to 170 pounds, and the engines averaging 360 revolutions per minute. Everything worked very satisfactorily with the exception of a slight mishap to one of the circulating pumps, which compelled the engines to be run for the latter half of the trial without the water service to the bearings, thrust, etc. Nevertheless no trouble was caused by overheating, and the trial finished successfully. The armament of the "Havock" consists of one 12-pounder quick-firing gun, mounted on the conning tower forward, and three 6-pounder quick-firing guns, one on each side forward, and one aft on a high pivot. She also has one fixed bow torpedo tube and two revolving deck tubes, 18 inches in diameter. She carries an electric search light, supplied with current from one of Allen's dynamos, placed in the engine room, where are also the air compressors, evaporator, steering engine, etc. Messrs. Yarrow & Co. are also building a sister ship, the "Hornet," to be supplied with Yarrow's patent tubulous boilers, and her speed is expected to be 27 knots.—*The Engineer* (London).

MANUFACTURES.

The Ontario Malleable Iron Co., Oshawa, Ont., is erecting a molding and milling room to its plant.

The paper-making machines of the Russell Manufacturing Company, Lawrence, Mass., have been started.

The machinists in the employ of the Pope Manufacturing Company, Hartford, Conn., are working overtime.

The Keystone Suspension Fence Co., of Elmira, N. Y., has been incorporated; directors, L. B. Parkhurst and others.

The Hancock Disc Plow Co., Shreveport, La., has been incorporated. M. T. Hancock is president; capital stock $100,000.

The Kingsbury Box Co., of Coventry, Conn., has been organized with a capital of $25,000. The stockholders are Addison and L. A. Kingsbury.

The Stirling Company, 14 Cortlandt street, New York, has recently sold four 250 horse-power boilers to the Providence Union Railroad.

The silver works of Reed & Barton, the West Silver Co. and Poole & Roach, Taunton, Mass., are employing their customary quota of hands.

The Columbia (Pa.) rolling-mill, employing several hundred hands, which has been suspended for several months, has resumed on full time.

The latest move of the Kansas City (Mo.) Smelting and Refining Co. is the erection of a warehouse for the storage of copper and lead.

The employes of Blood's lower foundry, Manchester, N. H., who have been out more or less for the past few weeks, are about all at work again.

The Brilliant Iron and Steel Company, Wheeling, W. Va., has signed the Amalgamated scale and will resume in full force, giving employment to 200 men.

The Knoxville (Tenn.) engine and pump works has completed one large building for its plant, and will proceed with erecting a large foundry at once.

The Collins Manufacturing Company, of San Antonio, Tex., has expended $10,000 for additional machinery for foundry and architectural iron works.

The Ohio Tool Company has been chartered to be located at Auburn, N. Y., and Columbus, O., to manufacture tools and other articles. Capital, $350,000.

At a largely attended town meeting at Middleboro, Mass., it was voted 601 to 116 to purchase the Middleboro gas and electric plant and establish municipal lighting.

Rogers & Hubbard, Waterbury, Conn., will next week put in a new water-wheel of the Hercules pattern. This firm is preparing for a largely increased business.

The Iowa Farming Tool Company, of Fort Madison, Ia., has increased the capacity of its works, also its facilities for storing manufactured goods, by the addition of two shops.

The men employed on gun work by the Colts Patent Fire Arms Company, Hartford, Conn., have been put on full time. They have been working eight hours for several months.

Hart Foundry and Machine Works, Clarksburg, W. Va., have issued a new catalogue of engines, boilers and saw-mills. They make both automatic cut-off and throttling engines.

The Ball Bearing Car Wheel and Manufacturing Company, of Cleveland, has been incorporated for the purpose of manufacturing car wheels. The incorporators are Simon D. Wright and others.

The Pennsylvania Steel Works at Steelton, Pa., which have been running half time for the past three months, have resumed operations in every department, giving employment to about 4,200 men.

The entire rolling-mill plant of the Whittaker Iron and Steel Company, of Wheeling, W. Va., has been destroyed by fire. The loss is estimated to be from $85,000 to $100,000. The mill will be rebuilt.

The Burr & Houston Co., Franklin Iron Foundry, 33-39 Franklin street, Brooklyn, N. Y., who make a specialty of fine castings, inform us that business is very good with them, orders being quite satisfactory.

The new car barn for the Easton Traction Company, at Easton, Pa., will be built by the Berlin Iron Bridge Company, of East Berlin, Conn. It will be entirely of iron, 64 feet in width and 200 feet in length.

The five mills of the George H. Friend Paper Company and the American Tablet Company at Dayton, O., have been consolidated. The new company is incorporated under the laws of Illinois with a capital stock of $1,100,000.

Jogada Furnace Company, Chicago, Ill., issue a catalogue descriptive of the Jones under-feed mechanical stoker which is designed to prevent smoke and produce economy; certificates as to the value of the stoker are appended.

Dean Brothers, Indianapolis, Ind., are getting in the windows and the floors down in their extensive new shops, and will soon, should business improve, be placing the machinery in position, disposing of their old plant when opportunity offers.

The Westinghouse Air-brake Company, Pittsburgh, Pa., will resume operations in every department at its Wilmerding works within a short time, after an idleness of several weeks, while some extensive repairs were being made.

The Summer Bottle Works, Steubenville, O., which have been idle for nine months, the Mingo Steel Works, after a two weeks' shut down, and the Brilliant Steel and Iron Company, which has been shut down four months have resumed.

J. H. McEwen Manufacturing Company, steam engine builders, Ridgway, Pa., write us under date of November 13th, "Business is picking up nicely with us. We have orders ahead for sixteen engines varying from 80 to 300 horse-power."

Dodge Manufacturing Company, Mishawaka, Ind., received Columbian Exposition medals and diplomas for their patent Bushing system for split pulleys; for split wood pulleys; for wood and iron dynamo pulleys, and for their chain oiling journal box.

The Boston Gear Works, 31 Hartford street, Boston, Mass., state that their 1894 catalogue will be ready about the middle of January, and that applications for copies received in the meantime will be placed on file, and copies mailed when ready.

The Carpenter Steel Company, Reading, Pa., which has furnished the government with $750,000 worth of projectiles, has received another order for coast defense purposes, which will keep the firm busy for two years. Over 400 men are employed.

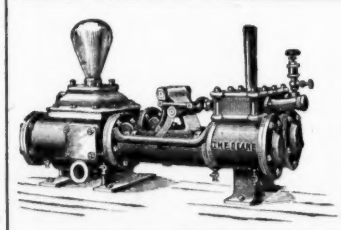
It is stated that the steel rail-mill located at Alexandria, Ind., last spring by the DePauws, and which was partially completed when the DePauws failure occurred, will be finished by the Union Trust Company, which was made assignee of the DePauws.

A Troy (N. Y.) dispatch says: The striking employes of the Cohoes Rolling-mill agreed to return to work, accepting a reduction of 50 cents a ton on all iron manufactured, with the understanding that the reduction will be restored as soon as business warrants.

The Pittsburgh Iron and Steel Engineering Company is erecting a number of iron buildings for Wm. Clark's Son & Co. These buildings are three in number, being 100x100, 60x218, and 56x260 feet in size, and will replace former frame structures recently damaged by fire.

The Southern Pacific R. R. Co. will build a new cotton shed at New Orleans, 120 feet wide and 350 feet long. They have placed the contract with the Berlin Iron Bridge Company, of East Berlin, Conn. The building will be entirely of iron, the sides being made with the Wilson patent rolling shutters.

An addition to the Homestead works of the Carnegie Steel Company is soon to be erected, to consist of a new blooming-mill to replace the one now in the 28-inch mill. The machinery will also



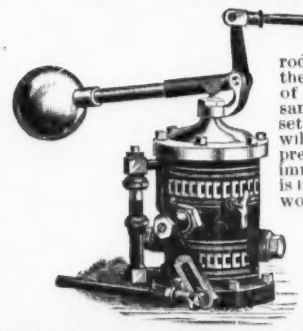
THE DEANE
OF HOLYOKE
STEAM PUMPS
DEANE STEAM PUMP CO.,
HOLYOKE, MASS.

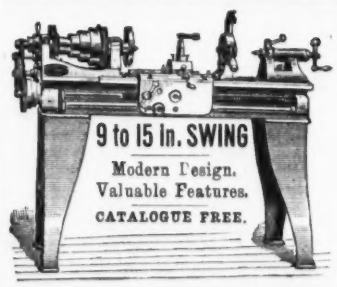
CRESCENT STEEL CO.
PITTSBURG, CHICAGO, NEW YORK.
STEEL FOR Lathe and Planer TOOLS, Cold Chisels, Punches & Dies, Milling Cutters, Molding Bits, &c.
SHEET STEEL, POLISHED Drill Rods, SPRING STEEL, Machinery Steel, COILED SPRINGS, Steel Forgings, ETC.

FINE TAPS, DIES, REAMERS, Etc.

LIGHTNING AND GREEN RIVER Screw Plates.
Tap Wrenches, Bolt Cutters, Hand and Power Drilling Machines, Punching Presses and Other Labor-Saving Tools.
WILEY & RUSSELL MFG. CO., Greenfield, Mass. SEND FOR NEW CATALOGUE.

"R. MUSHET'S SPECIAL STEEL"
SAVES LABOR in being able to run at GREATLY INCREASED SPEEDS. FEWER GRINDINGS. No WASTE in redressing.
SOLE REPRESENTATIVES IN THE UNITED STATES.
B. M. JONES & CO.,
BOSTON: 11 & 13 Oliver St., NEW YORK: 143 Liberty St.

THE MASON PUMP GOVERNOR.

The Mason Pump Governor is to the direct acting steam pump what the ordinary ball governor is to the steam engine. It attaches directly to the piston rod of the pump and operates a balanced valve placed in the steam pipe, thereby exactly weighing the amount of steam to the needs of the pump, and economizing the same. By using the Mason Governor, you can instantly set or change your pump to any required speed which will be maintained in spite of variation in load or steam pressure. As all the working parts of the governor are immersed in oil, the wear is reduced to a minimum. It is largely used on vacuum pumps, deep well pumps, water works pumps, ice machines, and all classes of pumps requiring an uniform strike.
For large duplex pumping engines a special governor is made, fitted with double parts and connected with both piston rods, thus insuring perfect regulation for every portion of each revolution of the engine.
MASON REGULATOR CO., Boston, Mass., U. S. A.



SEBASTIAN LATHE CO.
117 & 119 Culvert St., Cincinnati, O.
Manufacturers of Foot and Power
ENGINE AND SPEED LATHES,
For General Machine and Jobbing Shop, Electrical and Experimental Work.
DEALERS IN MACHINISTS' TOOLS AND SUPPLIES.

BUFFALO BLOWERS
FOR CUPOLAS, FORGES, FURNACES &C. EXHAUSTERS, STEAM FANS HEATERS & VENTILATING WHEELS.
BUFFALO FORGE CO. BUFFALO, N.Y.

BORING AND TURNING MILLS.
37, 51 and 62 Inch Swing, with Two Regular Heads.
42 INCH SWING, WITH TURRET HEAD, AND SCREW CUTTING ATTACHMENT.
All gears accurately cut. All feeds positive.
Machines are self-contained and therefore do not require an expensive foundation.
BRIDGEPORT MACHINE TOOL WORKS,
E. P. BULLARD, Prop. BRIDGEPORT, CONN.
New York Office, 39 CORTLANDT STREET, ROOM 86.

H. W. JOHNS'

ASBESTOS SECTIONAL PIPE COVERINGS.
NON-CONDUCTING COVERINGS FOR STEAM AND HOT WATER PIPES, BOILERS, ETC.
ASBESTOS BOILER COVERINGS.
H. W. JOHNS MANUFACTURING COMPANY,
H. W. Johns' Asbestos Millboard, Sheathings, Building Felts, Fire-Proof Paints, Liquid Paints, Asbestos Roofing, Etc.
87 MAIDEN LANE, N. Y. JERSEY CITY, CHICAGO, PHILADELPHIA, BOSTON, LONDON

be replaced. The big iron building to be used as an extension to the armor press shops is about completed.

The Standard Gauge Steel Company, Beaver Falls, Pa., send us a finished gib and key for a connecting rod as a sample of their product. They are made of steel—well made in all particulars. This company make a specialty of machine keys of all sizes and shapes, with or without heads, straight or tapered, all their work being made to micrometer measurements.

D. Saunders' Sons, Yonkers, N. Y., have issued a new catalogue of pipe threading machines—power and hand—for large and small pipe, drilling and tapping machines for pipe fittings and general work, stocks and dies for hand-work, pipe cutters, pipe tongs and wrenches, pipe and combination vises, chucks, taps and dies, etc. The catalogue is fully illustrated.

Application has been made for a charter for an intended corporation to be known as the Diamond Steel Company, of Reading, Pa. The new concern propose to engage in the manufacture of iron, steel, or both. The plant of Rothenberger. Steel & Sassaman, in North Reading, will be transferred to this new corporation, and the mill will probably resume operations at an early date, as it is stated that a number of orders have already been received.

The new saw and grist-mill nearly completed by C. F. Witherel at Dexter, Me., will, when in operation, be quite an addition to Dexter's business interests. The building is 100 feet long, 30 feet wide, and two stories high. The railroad company has completed a spur track to the mill, and an elevator is to be built so that corn can be taken right from the cars. Besides grinding feed, he will put in machinery for sawing boards, shingles and laths. The boiler has been set, and the other machinery has arrived, and will be put in in a short time.—*Industrial Journal.*

James A. Burden started recently his combination horse-shoe machine, his latest patent. At one time it required three machines to make a perfect horse-shoe. A few years ago Mr. Burden invented a machine by which the operations of making a horse-shoe were reduced to two. By the combination horse-shoe machine a complete and perfect shoe is made by a single operation and is ready to be placed on the horse's hoof. The combination machine started off without a hitch, as if it had been in operation for years.—*Troy* (N. Y.) *News.*

The Connersville Blower Company, Connersville, Ind., write us: "We were granted an award on the blower we had on exhibition at the World's Fair, and under circumstances that attach unusual value and significance to the recognition. Furthermore this testimony on the part of the awarding committee to the merits of the cycloidal blower is being emphasized in a more tangible manner by engineers and practical business men, inasmuch as we already have enough contracts on hand to keep us fully occupied for two months to come."

Mr. George B. Woodruff, of Winsted, Conn., and Mr. Thomas W. R. McCabe, of Philadelphia, Pa., have associated themselves as co-partners, under the name of Woodruff & McCabe, for the purpose of inventing, designing and building special and automatic machinery of all kinds, with place of business at Winsted, Conn. Mr. Woodruff is a young man having a thorough practical and theoretical education in mechanics. He has been employed by the Gilbert Clock Company, for a number of years as inventor, and has taken out various valuable patents. Mr. McCabe is an older man who has had a large and varied experience in mechanical matters, having invented and patented several new devices and machines which are extensively used at the present time.

The Hayden & Derby Manufacturing Co., 111 Liberty street, New York, write us: "We have been awarded the highest reward and medal for our metropolitan automatic injectors, our metropolitan double tube stationary injectors, our metropolitan double tube locomotive injectors and our 'D. H.' ejectors. Special mention was made of our automatic injectors, calling attention to the fact that these injectors did not require any regulation or valves for the varying steam pressure. Special mention was also made of our double tube injectors as to the simplicity of the injector, and the fact that all wearing parts could be renewed by anybody without special tools. Our exhibit also received honorable mention, on account of its completeness."

Machinists' Supplies and Iron.

NEW YORK, November 18, 1893.

Iron—American Pig—We quote Standard Northern brands No. 1 Foundry, $14.00 to $15.00; No. 2, $13.50 to $14.25; Gray Forge, $12.25 to $12.50. Southern brands of good quality are obtainable at $13.00 to $14.00 for No. 1 Foundry; $12.00 to $13.00 for No. 2, and $11.25 to $12.00 for Gray Forge.

Antimony—The market is quiet and easy. We quote L. X., 9¾c. to 9¾c.; Cookson's, 10c. to 10¼c.; Hallett's, 9¼c. to 9¾c., and U. S. French Star, 10c.

Lard Oil—Prime City is quoted at 75c. to 76c.

Copper—The market is firm. Lake Copper is quoted at 10c. An advance of this price is expected. Casting Copper is held at 9.40c. to 9.50c.

Lead—The market is steady. The quotations are 3.45c; there are only a few sellers at this price, but the demand is active. Consumption continues good.

Spelter—The market is improving, holders are firm in their views, and quote 3.70c. to 3.80c. according to brand.

Tin—The market is weak. Bids are limited at 20.60c. for spot, and 20.65c. for the balance of the year

WANTED

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

First-class die tool maker wants position. Box 129, AMERICAN MACHINIST.

Position wanted as foreman patternmaker, 7 yrs' exp., first-class refs. Foreman, AM. MACHINIST.

Mechanical draftsman with college education desires a position. J., AMERICAN MACHINIST.

A reliable mech. draftsman (age 25) desires position A1 refs. Address Box 133, AM. MACHINIST.

(*Continued on page* 14.)

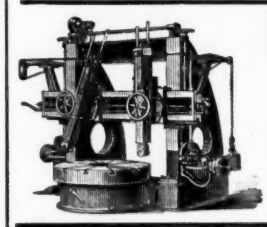
REDUCED PRICES OF LeCOUNT'S STRAIGHT TAIL DOG.

To be driven from a Stud in the Face Plate.

No.	INCH.	PRICE.	No.	INCH.	PRICE.
1	¾	$0.60	10	2¼	$1.35
2	⅞	.70	11	2½	1.45
3	1	.70	12	3	1.60
4	1⅛	.80	13	3½	1.80
5	1¼	.80	14	4	2.10
6	1⅜	.95	15	4½	2.75
7	1½	.95	16	5	3.25
8	1¾	1.10	17	5½	4.00
9	2	1.20	18	6	5.00
1 Set to 2 in.		7.80	Full Set,		31 0

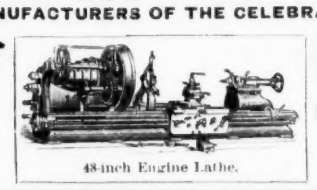
These Goods are for sale by CHAS. CHURCHILL & CO., L't'd, 21 Cross St., London, England.

C. W. LeCOUNT, South Norwalk, Conn.



BORING AND TURNING MILLS
COMBINING EVERY IMPROVEMENT.
14 SIZES FROM 5 TO 20 FEET.
BETTS MACHINE COMPANY,
WILMINGTON, DEL.
Chicago Office: 14 South Canal St.

FITCHBURG MACHINE WORKS,
MANUFACTURERS OF THE CELEBRATED
FITCHBURG MODERN ENGINE LATHE
AND OTHER METAL-WORKING MACHINES



48-inch Engine Lathe.

SEND FOR CATALOGUE E.
FITCHBURG, MASS.

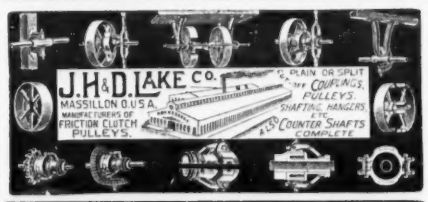
ENGINE RUNNERS' CATECHISM,
Telling how to Erect, Adjust and Run the principal Steam Engines in Use in the United States.
By ROBT. GRIMSHAW, M. E.,
18mo, RED CLOTH, - 2.00.
JOHN WILEY & SONS, NEW YORK

SMALL MACHINE SHOP
36 x 38 FT. FOR SALE OR TO LET.
210 E. 43d St., NEW YORK.
WATSON & STILLMAN.

GRANT GEARS
Ready Made Cut Gears.
Ready Made Cast Gears.
Ready Made Brass Gears.
Gears Made to Order.
Gear Cutting.
Gear Book, 15 cents.
Treatise on Gears, $1.00.
Gear Cutting Machines.
GEORGE B. GRANT,
Lexington, Mass.,
and 125 South 11th St.,
Philadelphia, Pa.

"Star" Foot Lathe Swings 9x25 in. | Screw Cutting Automatic Cross Feed, etc.
LATHE
Scroll Saws, Circular Saws, Lathes Mortisers. | Catalogue Free of all our Machinery.
Seneca Falls Mfg. Co. 687 Water St., Seneca Falls, N.Y.

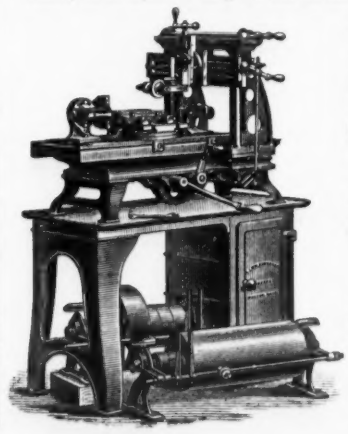
JESSOP'S STEEL
FOR TOOLS, DRILLS, DIES, &c.
ALL KINDS IN STOCK.
Manufactory, SHEFFIELD, ENG.
Chief Am. Office, 91 JOHN ST., N. Y.
WM. JESSOP & SONS, LTD.
Established a century ago.
Medal World's Columbian Exposition 1893.



The German-American Emery Wheel Co.,

Manufacturers of
SOLID EMERY WHEELS.
Discount 80 per cent. on Circular Price List. Send for it.
AGENTS WANTED.
Cor. High Point and Summit Avenue,
HOBOKEN, N. J.

POWER OR HAND PLANER.
FOR MODEL MAKERS, EXPERIMENTAL WORK, &c.
Has all the Improved Features Usually Found on High Grade Planers, and is Capable of Doing the Best and Finest Work.



MANUFACTURED BY
A. J. WILKINSON & CO.,
184 Washington Street, Boston, Mass.

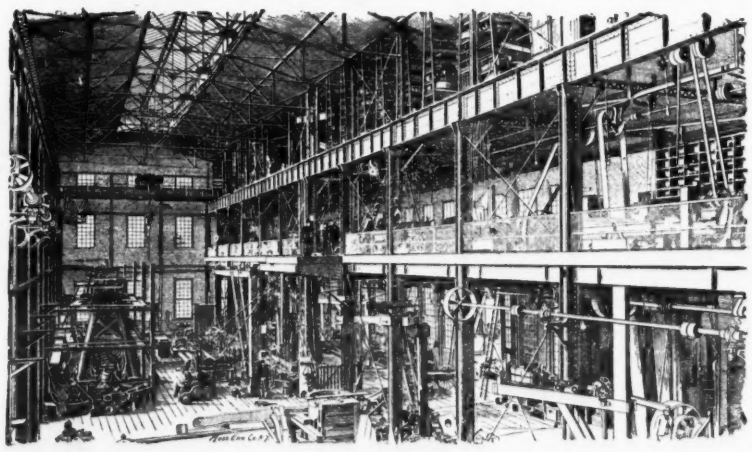
WORTHINGTON PUMPING ENGINE
FOR
WATER WORKS.
SIMPLE, COMPOUND, OR TRIPLE EXPANSION,
HORIZONTAL OR VERTICAL
HIGHEST DUTY GUARANTEED.
COMPLETE DESCRIPTIVE PAMPHLETS ON APPLICATION.
HENRY R. WORTHINGTON,
NEW YORK,
BOSTON, PHILADELPHIA, CHICAGO, ST. LOUIS, DENVER.

DON'T ACCEPT ANY SUBSTITUTE FILE.
INSIST ON HAVING
NICHOLSON.

NICHOLSON FILE CO.
PROVIDENCE, R. I., U. S. A.
3000
VARIETIES FILES
[X. F.] & INCREMENT CUT FILES.

THE BERLIN IRON BRIDGE CO.
Office and Works,
No. 8 Railroad Ave., East Berlin, Conn.
CHAS. M. JARVIS, Pres. and Chief Engineer. BURR K. FIELD, Vice-President.
FRANK L. WILCOX, Treasurer. GEO. H. SAGE, Secretary.

Engineers, Architects and Builders of



Iron and Steel Bridges and Buildings.

The above illustration is taken direct from a photograph and shows the interior of a Machine Shop designed and built by us for The Dry Dock Engine Co., at Detroit Mich. The central portion or Erecting Room is 40 feet wide, with a gallery three stories high on one side, this gallery being 27 feet in width. The upper floor of the gallery is used for storing patterns, while the second floor is used for light machine work and the lower floor for heavy machine work—this lower floor being controlled by jib cranes, which also swing out into the central portion, thus delivering material from the wings by means of the jib cranes and the traveling crane to any portion of the Erecting Room. The whole frame-work of the building is of Iron, with brick filling for the side walls.

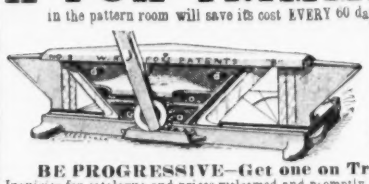
SEND FOR OUR ILLUSTRATED CATALOGUE.

COOKE & CO.,
163 & 165 Washington Street,
NEW YORK.

WATERS PERFECT ENGINE GOVERNOR.
Simplest and most sensitive.
WRITE FOR PRICE LIST AND MENTION THIS PAPER.

HENRY CAREY BAIRD & CO.,
INDUSTRIAL PUBLISHERS, BOOKSELLERS AND IMPORTERS,
810 Walnut St., Philadelphia.
Our New and Revised Catalogue of Practical and Scientific Books, 88 pages, 8vo., and our other Catalogues and Circulars, the whole covering every branch of Science applied to the Arts, sent free and free of postage to any one in any part of the world who will furnish his address.

A FOX TRIMMER
in the pattern room will save its cost EVERY 60 days.



OVER 7,000 SOLD.
BE PROGRESSIVE—Get one on Trial.
Inquiries for catalogue and prices welcomed and promptly answered.
FOX MACHINE CO.,
325 No. Front St., Grand Rapids, Mich.
135 Finsbury Pavement, London, England.

WANTED

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

First-class brass molder wants position as foreman or work in small shop where steady man is required. Allen. American Machinist.

Mechanical and milling engineer, desires to make a change. A1 refs. R. W., 331 41st. St., Chicago, Ill.

Mechanical engineer wishes charge of branch house, Chicago, or west; is exp'd in engs, boilers, steam pumps, designing, estimating, contracting & handling salesmen. A1 refs. Box 132. Am Mach.

Experienced draftsman is open for engagement. Accustomed to working out designs from sketches and instructions. Dynamo and motor work preferred. References. Box 131, Am. Machinist.

Pattternmaker, 1st-class, 31, wants steady work in the west. 2½ years foreman, machine, architectural and stove, good habits, 1st class refs., certificated draftsman. Trebia, American Machinist.

Wanted—A machine shop foreman on steam engine work. Only first-class and experienced men need apply. To such a man we offer a permanent pos. and good salary. Engine Builder, Am. Mach.

Wanted—Position as superintendent by a man with long experience in equipping plants, reducing cost and systematic methods and handling men; best of refs. Address A. C. B., care Amer. Mach.

Patternmaker, 25 years' experience, 14 years foreman, desires situation; experience, engineering, electrical and textile for green sand and loam castings; best of refs. Address Box 130, Am. Mach.

A member of the A. S. M. E., 38, married, desires position as general superintendent or manager of machine works, where executive ability, practical knowledge of the business in all its details, integrity and devotion to the interests of the concern, would be appreciated and suitably rewarded. W. O. W., American Machinist.

✢ MISCELLANEOUS WANTS ✢

Advertisements will be inserted under this head at 35 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded

Cheap 2d hd lathes & planers. S. M York, Clev'd, O.

Auto. Steam Flue Cleaners. Kelley Co., Erie, Pa

For Sale—Second-hand drill presses, engine lathes & planers. Dietz. Schumacher & Co., Cincinnati, O

Light and fine machinery to order: Foot Lathe Catalogue for stamp. E. O. Chase, Newark, N. J.

Monitor lathe $85; screw-cutting lathe 18" swing $85; engine and boiler 10 H.P. $110. 229, Am. Mach

Wanted—Light machinery or specialties to build. P. G. Fleming's Machine Works, Elizabeth, N. J.

For Sale—One 27'x14 foot bed screw cutting engine lathe. A splendid tool in first-class condition. C. M. & J. B. Hart, Clarksburg, W. Va.

Agents—$5 Speed Gage, new, valuable, sells' shows constantly speed and slightest variations. Geo. T. McLauthlin & Co., 120 Fulton St., Boston.

For Sale—Hand-power traveling crane, 16-foot span, with racking gear and brake; low price; terms cash. The Sargent Company, Chicago, Ill.

Wanted A 30 H. P. engine, boiler and lot of shafting in exchange for dividend-paying gold mining stock. J. H. Allen, 244 Washington St., Boston, Mass.

For Sale—A small machine shop well equipped with first class machines and tools. For particulars address H. F. Quickel, P. O. Box 27, Harrisburg, Pa.

Wanted—A portable saw-mill suitable for sawing timber for mining purposes in exchange for dividend-paying gold mining stock. Address J. H. Allen, 244 Washington St., Boston, Mass.

Introduction and negotiation of American patents and machinery to English manufacturers and agents. Write for circular to Geo. Richards, M. I. M. E., Mechanical and Consulting Engineer, No. 5 Laurence Pountney Hill, London, England.

Established in 1874.
CLEVELAND TWIST DRILL CO.
Corner Lake & Kirtland Sts., Cleveland, O
100 & 102 Reade Street, New York.
85 Queen Victoria St., London, Eng.

BEVEL GEARS,
Cut Theoretically Correct.
For particulars and estimates apply to
HUGO BILGRAM,
MACHINIST,
Successor to
BREHMER BROS.,
440 N. 12th St., Philadelphia, Pa.

American Standard Gauge & Tool Works,
WILMINGTON, DEL.

Adjustable Blade Reamers,
1/8 in. to 2½ in.
Send for New Pamphlet.
JAMES A. TAYLOR & CO.

SECOND-HAND MACHINERY.
MODERN STYLE. GOOD ORDER. LOW PRICES.

ENGINE LATHES.
13 in. x 6 ft. Raise and Fall Rest. - - Blaisdell
14 " 6 " " " complete. Fitchburg
15 " 6 " Plain Rest—Cross Feed. - Perkins
16 " 6 " Compiete, - - - New Haven
16 " 7 " Heavy Pattern. - - Bridgeport
16 " 8 " Reverse Motion. - - - - Ames
18 " 8 " Plain Rest—Cross Feed. - Putnam
20 " 8 " Compound Rest—Cross Feed. Putnam
24 " 12 " " " " Fitchburg

PLANERS.
20 in. x 5 ft. Auto. Feeds—complete. New Haven
21 " 4½" " " Whitcomb
24 " 8 " " " Freeland
30 " 8 " " " Pond
35 " 7 " " " Hewes & Phillips

SHAPERS.
8 in. Stroke, Crank Motion. - - - Gould
12 " " " - - - Prentiss
15 " " Friction. - - - - - Hendey
15 " " Crank Motion. - - - Improved

SCREW MACHINES.
Brown & Sharpe No. 1, with Wire Feed, 7/16 in.
Garvin No. 1, with Auto. Chuck, 5/8 in.
Niles, with Carriage—Auto. Fds. Ckg. & Tools, 1⅞ in.

Miscellaneous.
Lincoln Milling Machine.
Ames 24 in Drill—Back Gears—Automatic Feed.
New Haven 40 in. Drill. " " "
Radial Drill, with 5 ft. Arm.
Upright Boring and Turning Mill, 38 in.
Vertical Turret Ckg Machine, 36 in. Brown & Sharpe Bolt Cutters, Pipe Cutters, Presses, &c.

BOILER BENDING ROLLS.
8 ft. Improved Style, with Hinged Housing.

J. J. McCABE,
SUCCESSOR TO
E. P. BULLARD'S
N.Y. Mach'y Warerooms.
14 Dey St.,
NEW YORK.

HERE ARE SOME
BARGAINS
IN SECOND-HAND MACHINERY
from the Equipment of the **United Electric Traction Co.'s Works**, of Marion, N. J., comprising
Reed, Prentice, Ames, Jones & Lamson and other Engine Lathes, 14' to 20" swing.
1 48"x18' Pond M. T. Co.'s Engine Lathe.
1 11" Newton Slotter.
1 No. 2 Betts Horizontal Boring Mill, with lot of fixtures.
1 each 36', 48", and 60" Gould & Eberhardt Automatic Gear Cutters,
1 24"x5' Pond M. T. Co.'s Planer.
Shapers, 10", 12" and 15"stroke.
Drill Presses up to 25" swing.
Milling Machines, Plain and Universal.
2 Brown & Sharpe Screw Machines.
2 Large Bliss Power Presses.
Hand Lathes, 10" to 20" swing.
1-10 H. P. Baxter Engine, with 15 H. P. Boiler, complete, good as new.
Also, Tool Grinders, Die Sinkers, Tapping Machines, Bolt Cutters, and large Pattern and Blacksmiths' Shop Equipments.
The tools are in excellent order and of the best makes. They will be sold at remarkably low prices
Call at our salesroom and inspect them, or write for complete descriptive circular and price list.
THE GARVIN MACHINE CO.,
LAIGHT & CANAL STS., NEW YORK.

IF YOU WANT ANYTHING IN THE LINE OF
DROP PRESSES-DROP HAMMERS-STAMPS
OR AUTOMATIC DROP LIFTERS
SEND FOR CATALOGUE TO
MINER & PECK MFG. CO.
NEW HAVEN, CONN.
LARGEST LINE IN MARKET.

GRAHAM TWIST DRILL AND CHUCK CO., DETROIT, MICH., U. S. A.
SOLE MANUFACTURERS OF
GRAHAM'S GROOVED SHANK TWIST DRILLS AND CHUCKS.

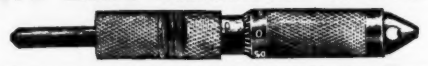
Endorsed by Practical Mechanics Everywhere. Send for Catalogue

HARD FIBRE.
A Substitute for Hard Rubber, Brass, Rawhide and Leather, made Hard or Soft, in Sheets, Rods, Tubing, Washers, &c.
Send for Catalogue and Samples.
DELAWARE HARD FIBRE CO.,
Wilmington, Del.
And 15 Long Lane, London, E. C.

BOSTON GEAR WORKS
35 HARTFORD ST., BOSTON, MASS.
GEARS, ALL KINDS, SMALL OR LARGE.
300 LIST IRON, 600 LIST BRASS
Catalogue FREE to any Business Firm.

BOILER AND MACHINE SHOP
MACHINERY
NEW AND SECOND HAND.
Boiler Rolls, 8 ft 3 in. between Housings.
Punch, 21 in. Throat, with shear Block.
Hand Power Boiler Rolls.
Boiler Clamp
Engine Lathes, from 12 in. to 92 in. Swing.
Planers, " 20 " " 62 " Wide.
Drills, " 16 " " 44 " Swing.
Radial Drill, Hilles & Jones, 48 " Arm.
Turret Lathes, No. 12, Jones & Lamson. A1.
No. 0, Am. Tool & Mach Co A1.
Wheel Lathe, 88 in Swing, with Two Tool Carriages
Quartering Machine, Bement, Double Right and Left Hand.
Stiles Presses, No 4, Fowler No. 0 and 1½.
Pratt & Whitney Screw Machines, No. 1, 2 and 3.
Garvin No. 4 Miller, No. 2 Hand Miller.
Pratt & Whitney No. 3 Hand Miller.
Drop Hammer Dynamo, large lot, Polishing Mchy., Belting, &c.
SEND FOR OUR LATEST LIST.
GEO. PLACE MACHINE CO.,
Warehouse: 511 and 513 WEST 13th STREET.
Office: 120 BROADWAY, NEW YORK.

ST'D INSIDE MICROMETER CALIPER.

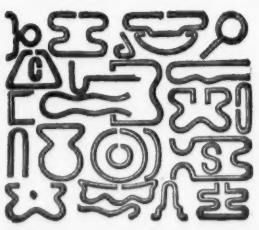


It measures by thousandths from 2½ to 13 inches. Write for circular.
J. T. SLOCOMB & CO., Providence, R. I.

CASTINGS
For Machinery of any size, from patterns or drawings. Quality and finish unsurpassed. Prices way down.
L. E. HOYT & CO.,
WALTON, DEL. CO., N. Y.
New York Agent, CLEVELAND FOOTE, 47 Broadway.

SOFT CASTINGS,
Made from best grades of Pig Iron for Light Machinery, Electric Work, etc.
THE BURR & HOUSTON CO.,
33 TO 39 FRANKLIN ST., BROOKLYN, N. Y.

EICKEN & CO.'S CRUCIBLE TOOL STEEL
HAGEN, WESTPHALIA, GERMANY.
SPECIAL No. 8, makes a fine finish on the hardest Rolls; Boss Cold Chisel Steel; High Grade Twist Drill, Tap, Punch, Reamer, Wood and Milling Cutter Steel and Blanks.
The HIGHEST QUALITY; Inducements to the Trade and large Users.
REPRESENTED BY EDW'D VORSTER. IMPORTERS & EXPORTERS. MARKT & CO., Agts. 79-85 N. Moore St., New York.



BLAKE & JOHNSON,
WATERBURY, CONN.
Builders of WIRE FORMING MACHINES
With F. B. Manville's Patent Sliding Former,
For making articles from the coil, of either round, half-round, flat, or square wire, similar in shape to those shown in the cut herewith. Also similar articles made to order.
Send samples of articles required, and mention quantity wanted, that we may quote prices for either machine or the goods, whichever may be desired.
Bicycle and Labor Saving Machinery a Specialty.

SEND FOR CATALOGUE.
WORCESTER MACHINE SCREW CO
WORCESTER, MASS.
Manufacturers of Set, Cap & Machine Screws, Studs, etc.

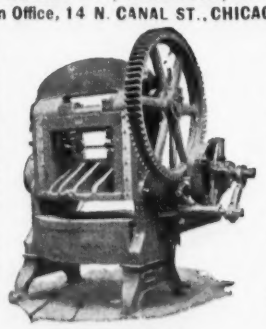
MACHINERY
For Reducing and Pointing Wire.
ESPECIALLY ADAPTED TO POINTING WIRE RODS AND WIRE FOR DRAWING.
For Machines or Information address the Manufacturer,
S. W. GOODYEAR, Waterbury, Conn.

WE LEAD, OTHERS TRY TO FOLLOW.
If it is not true that we are building THE BEST BLOWER now on the market, why this haste on the part of others to discard methods of construction long considered by them as good enough, and why their efforts to imitate our new ideas?
When you require a positive blast and want something efficient and economical, write to
THE CONNERSVILLE BLOWER CO.,
CONNERSVILLE, IND.

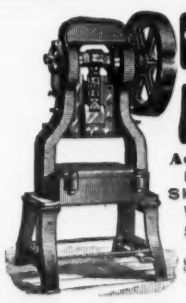
CLAMP DRILLS
In two Styles and four Sizes. Send for circular to
GEO. BURNHAM & CO.,
Worcester,
MASS.

GEAR & PULLEY CASTINGS
MOULDED BY MACHINE.
Any size and face of Pulleys. Any size face and pitch of Gears, spur, worm or bevel. Address,
T. SHRIVER & CO.,
IRON FOUNDERS.
333 EAST 56TH STREET, NEW YORK.

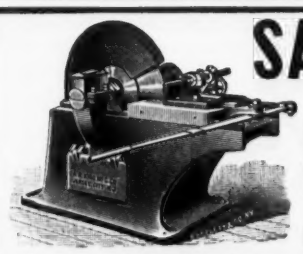
E. W. BLISS CO.,
1 ADAMS ST., BROOKLYN, N. Y.
Western Office, 14 N. CANAL ST., CHICAGO, ILL.
Punching and Drawing Presses, Drop Hammers.



Dies, Shears and Special Machinery.
OWNERS OF
THE STILES & PARKER PRESS CO.

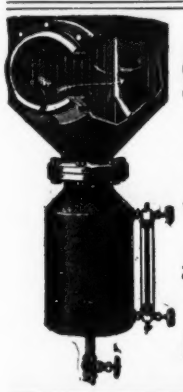


POWER PRESSES
Adjustable. Improved.
FOR TIN, BRASS AND SHEET IRON WORKERS.
WORKMANSHIP GUARANTEED.
STRONG AND DURABLE.
Send for Circulars.
SPRINGFIELD MACHINE TOOL CO.
SPRINGFIELD, OHIO.



SAW FOR Cutting Hot Iron or Steel.
A. R. KING MFG. CO.,
ERIE, 11th & 12th Sts.,
JERSEY CITY, N. J.
MACHINERY AND TOOLS.
Heavy Machine Castings.

At the World's Columbian Exposition the highest medals were awarded to the
P. H. & F. M. ROOTS CO.,
FOR THEIR
PRESSURE BLOWERS, GAS EXHAUSTERS, FORCE PUMPS, PORTABLE FORGES, BLACKSMITHS' BLOWERS, and COMBINED FIRE BED and TUYERE IRON.
These are recognized as the leading machines in the market.
S. S. TOWNSEND, Gen. Agt., COOKE & CO., Selling Agts. 163 & 165 Washington St. NEW YORK.
Catalogues, prices, etc., on application.



COCHRANE SEPARATOR

The Best Apparatus on the Market for

OBTAINING DRY STEAM

AND REMOVING

WATER, OIL, GREASE

And Other Impurities from Exhaust Steam.

30 DAYS TRIAL.

Efficiency Guaranteed.

Send for Circular and Price List.

Harrison Safety Boiler Works,

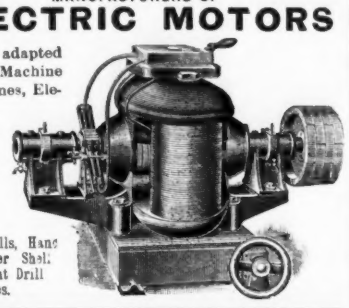
Germantown Junction, Phila., Pa.

THOS. H. DALLETT & CO.,

YORK ST. & SEDGLEY AVE., PHILADELPHIA.

MANUFACTURERS OF

ELECTRIC MOTORS

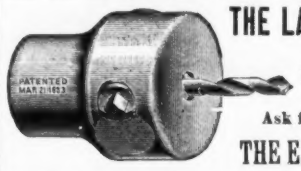


Specially adapted for driving Machine Tools, Cranes, Elevators, Pumps, Presses and other Machinery.

Also

Portable Drills, Hand Drills, Boiler Shell Drills, Light Drill Presses.

Ask your nearest Dealer, or send to the Manufacturers for

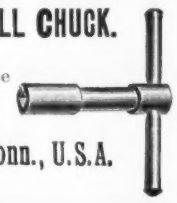


THE LATEST AND THE BEST TWO JAW DRILL CHUCK.

Strong, Accurate, Durable, Cheap.

Made entirely of Steel, Body Solid, of but one piece of Metal.

Ask for Style B.—Holds from the smallest to ¼ inch.

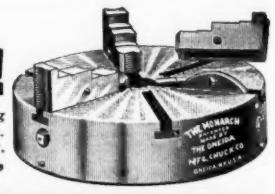


THE E. HORTON & SON CO., Windsor Locks, Conn., U.S.A.

Or CHAS. CHURCHILL & CO., Ltd., 21 Cross St., Finsbury, London, England.

HAVE YOU SEEN IT? WHAT?

THE MONARCH LATHE CHUCK!



The greatest labor saving tool of its kind ever made. Has the quickest reversing jaws ever invented. Single piece of metal in body, which insures strength. Pat. V hole in carrying nut, pulls jaw close to face of chuck when gripping work. Manufactured by THE ONEIDA MFG. CHUCK CO., Oneida, N. Y., U. S. A. Send for illustrated catalogue.

CUSHMAN CHUCKS.

We have recently improved our full line of Geared Scroll Chucks and have also added a 10½ inch and a 15 inch. Prices and discount on application.

Send for our catalogue of all kinds of Lathe and Drill Chucks.

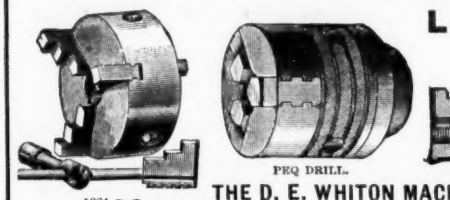
THE CUSHMAN CHUCK CO., HARTFORD, CONN.

NORTON

EMERY WHEEL CO.,

WORCESTER, MASS.

Send for Illustrated Catalogue.



1884 PAT

PEQ DRILL.

SECTION INDPT.

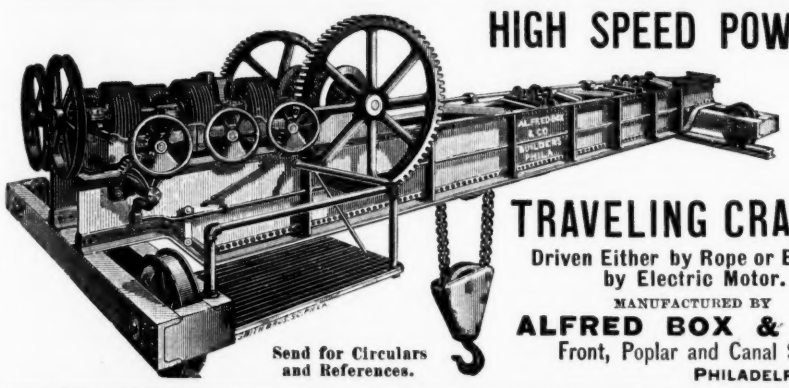
LATHE AND DRILL CHUCKS.

Buyers should note quality first and then price. We have made improvements which greatly increase the durability and accuracy of our tools. Please investigate our claims. We carry a large variety in stock, and design chucks and chucking tools for special purposes. Have you read our late catalogue?

THE D. E. WHITON MACHINE CO., 5 Oak St., New London, Conn., U.S.A.

OR SELIG, SONNENTHAL & CO., 85 QUEEN VICTORIA ST., LONDON, E. C., ENGLAND.

HIGH SPEED POWER



TRAVELING CRANES.

Driven Either by Rope or Belt, or by Electric Motor.

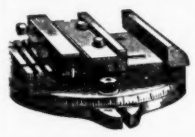
MANUFACTURED BY

ALFRED BOX & CO.,

Front, Poplar and Canal Sts.,

PHILADELPHIA, PA

Send for Circulars and References.



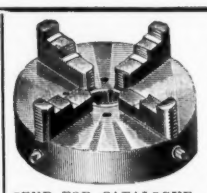
Jordan Planer Chucks.

SEND FOR CIRCULAR.

C. W. JORDAN,

4 Wayne St.,

WORCESTER, MASS.



SKINNER CHUCKS.

Independent and Universal Chucks, Combination Lathe Chucks with patent reversible jaws, Drill Chucks, Planer Chucks and Face Plate Jaws.

SEND FOR CATALOGUE.

SKINNER CHUCK CO., New Britain, Conn.

Cranes

CUPOLAS, LADLES, TRUCKS,

Detroit Foundry Equipment Co.,

702 TEMPLE COURT, CHICAGO. | DETROIT, MICH.

NEW YORK OFFICE, 182 FRONT ST.

Write **The Pratt Chuck Co.**, Clayville, N. Y., U. S. A., for free illustrated catalogue of

POSITIVE DRIVING DRILL CHUCKS,

made in eleven sizes and two styles, showing the only perfect system ever devised for holding and driving drills.

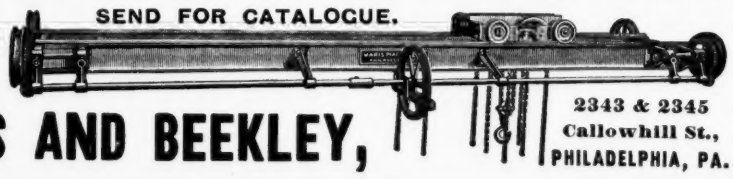
FOREIGN AGENCIES:

Ph. Roux et Cie, 54 Boulevard du Temple, Paris, France; E. Sonnenthal, Jr., Nueu Promenade No. 5, Berlin, Germany; Selig, Sonnenthal & Co., 85 Queen Victoria St., London, E. C., England.

CRANES, TROLLEYS, PORTABLE HOISTS, OVERHEAD TRACK.

WORLD'S FAIR, Machinery Hall, Section 26, Column 0. 30.

SEND FOR CATALOGUE.



MARIS AND BEEKLEY,

2343 & 2345 Callowhill St., PHILADELPHIA, PA.

Something New in Mechanics!

GEOMETRIC

Boring and Turning Tool.

An attachment to a drill press for boring and turning any geometrical figure, such as round, square, hexagon, octagon, triangle, diamond, star, oval, half-round, etc., in metals, wood or stone.

For particulars and prices address.

A. T. SHOEMAKER,

115 Broadway, New York City.

STARRETT'S UNIVERSAL

Surface Gauge

FOR TOOL-MAKERS.

No. 56.—Weighs, 11 oz. 5 in. high. Steel base, case hardened. Has my improved Sleeve. Spindle can be set in any position from vertical to horizontal. Scriber can be used below base for Depth or Marking Gauge.

PRICE, $3.00.

Tools warranted. Catalogue free.

L. S. STARRETT,

ATHOL, MASS., U.S.A.

London Agents: Chas. Churchill & Co., Limited, 21 Cross Street, Finsbury, E. C.

CUT

WITH OUR

NO. 3 FLEETWOOD SAW

Fitted for FOOT or STEAM POWER.

A HANDY TOOL TO HAVE IN YOUR SHOP.

Write for description and price to

TRUMP BROS. MACHINE CO.

MANUFACTURERS,

WILMINGTON, DELAWARE.

FOR SALE BY

CHAS. CHURCHILL & CO., Limited,

No. 21 Cross Street, Finsbury, London, England.

Stover Power Hack Saw and Friction Drill.

This Drill is for light, sensitive and rapid drilling. Has greatest power when speed is slow, and is most sensitive when speed is high.

Power Hack Saw is made in two sizes, No. 1 cuts off metal up to 4½ in. No. 2 cuts off metal 6 in. x 8 in. Satisfaction guaranteed. Send for circulars and prices.

STOVER NOVELTY WORKS,

23 River Street, FREEPORT, ILL., U. S. A.

PRESSES, DIES, AND OTHER SHEET-METAL TOOLS

FERRACUTE MACHINE CO. BRIDGETON N. JERSEY U.S.A.

MACHINISTS' SCALES,

PATENT END GRADUATION.

We Invite Comparison for Accuracy with all others.

EVERY SCALE GUARANTEED. SEND FOR LIST.

COFFIN & LEIGHTON, SYRACUSE, N. Y.

Improved Lead Fillet for Pattern Makers.

SAMPLES FREE.

H. WHITE,

Sole Manufacturer,

44 North 4th St.,

PHILADELPHIA, PA.

"PRACTICAL DRAWING."

By J. G. A. MEYER.

This valuable series of 93 articles having been concluded, copies of the American Machinist containing them will be sent by mail to any address in the U. S., Canada or Mexico, for $4.65, or single copies, 5 cts. each, postpaid.

Order now before our stock of papers is exhausted.

ADDRESS:

American Machinist,

203 BROADWAY,

NEW YORK.

"MODERN LOCOMOTIVE CONSTRUCTION."

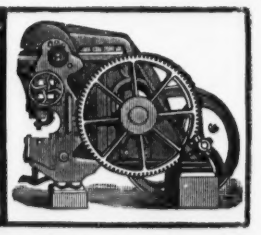
By J. G. A. MEYER.,

This valuable series of 106 articles having been concluded, copies of the American Machinist containing them will be sent by mail to any address in the U. S., Canada or Mexico, for $5.30 or single copies, 5 cts. each, postpaid.

PUNCHING AND SHEARING MACHINERY AND BOILER MAKERS ROLLS.

NEW DOTY MANUFACTURING CO.

JANESVILLE WISCONSIN.



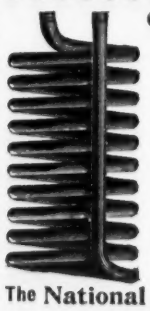
Dixon's Silica Graphite Paint

Will preserve a roof for TEN to FIFTEEN YEARS—perhaps longer, without repainting.

Unequaled for SMOKE STACKS, BOILER FRONTS, Etc.

Send for circulars on Paints and Painting.

JOS. DIXON CRUCIBLE CO., Jersey City, N. J.



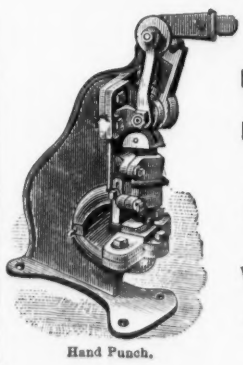
COILS and BENDS of IRON, BRASS, and COPPER PIPE of every description.

The National Pipe Bending Co.

52 River St., New Haven, Conn.

HYDRAULIC MACHINERY,

PRESSES, PUMPS, PUNCHES, JACKS, VALVES, FITTINGS, PACKINGS, ACCUMULATORS.



Hand Punch.

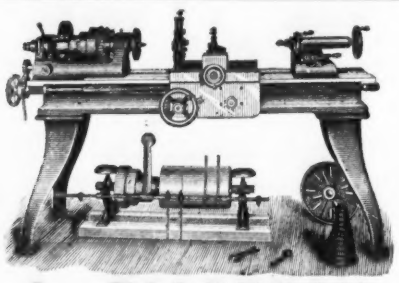
The W. & S. HYDRAULIC MACHINERY WORKS,

WATSON & STILLMAN, Proprietors,

204, 206, 208 & 210 East 43d St., NEW YORK.

Vreeland's Transfer Jack.

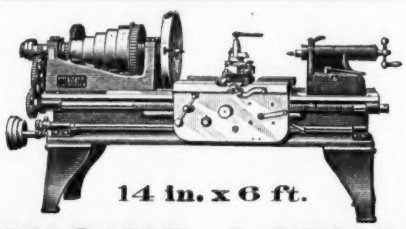
In use on over 50 Railroads.



A. FALKENAU,

11th Street & Ridge Ave., Philadelphia, Pa.

MANUFACTURER OF SUPERIOR 14 INCH LATHES, TOOL GRINDING MACHINERY, HYDRAULIC VALVES, ETC., Special Machinery designed and constructed.



14 in. x 6 ft.

ENGINE LATHE.

22 in. x 8 ft., 10 ft., 12 ft., 14 ft. x 16 ft.

LATEST IMPROVED ENGINE LATHES.

Patent Radial Drills a Specialty.

ADDRESS

DIETZ, SCHUMACHER & CO.,

Successors to DIETZ, GANG & CO.,

58 & 60 PENN ST.,

CINCINNATI, O., U. S. A.

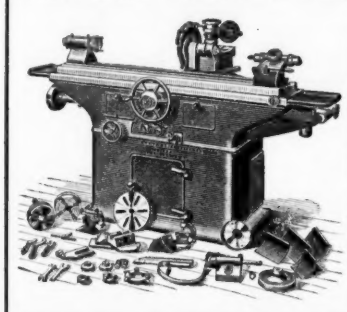
ELECTRIC CRANES AND TOOLS.

PAWLING & HARNISCHFEGER,

BUILDERS,

MILWAUKEE, WIS.

UNIVERSAL GRINDING MACHINES.



Latest Improvements. Warranted first-class in workmanship, material and design. For quick adjustment and rapid production unexcelled. For particulars, address LANDIS BROS., Mfrs., Waynesboro, Pa.

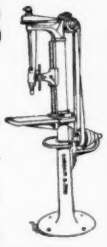
SENSITIVE DRILLS

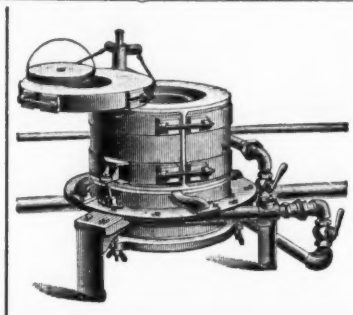
Complete Machines from $16 up.

SEND FOR CIRCULARS.

WM. GARDAM & SON,

98 John St., New York.





American Gas Furnace Co.,

OIL GAS PLANTS

AND

GAS BLAST FURNACES.

Send for Catalogue. Estimates made for any mechanical operation requiring **high, even** and **controllable temperature.**

No. 80 NASSAU ST.,

NEW YORK.

NO KEYS. NO KEY-SEATING. NO SLIPPING. STUART'S PATENT

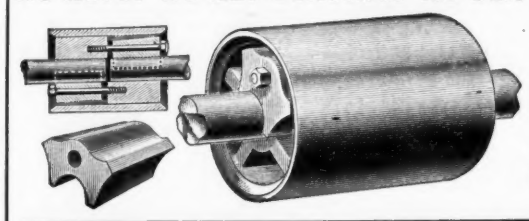
Compression Wedge Coupling.

SENT ON TRIAL.

Can be attached or removed in a few seconds without injury to shaft or coupling.

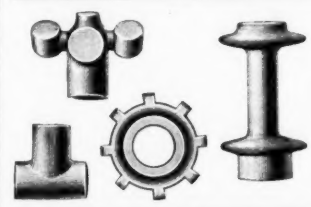
SIMPLEST and BEST in MARKET, Also the Cheapest.

Send for discount and illustrated Price List of 20 sizes.



R. J. STUART'S FOUNDRY AND MACHINE WORKS,

NEW HAMBURGH, N. Y.



WYMAN & GORDON

WORCESTER, MASS.

DROP FORGINGS

ELECTRICON.

The Best Anti-Friction Metal in the World.

FOR ALL

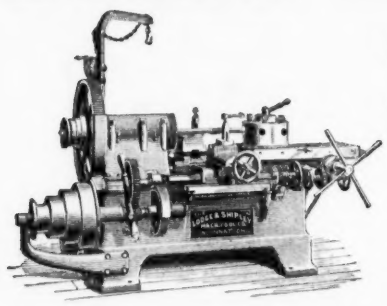
MACHINE, RAILWAY AND MARINE BEARINGS.

HIGH QUALITY. LOW PRICE. SEND FOR SAMPLE.

UNION ELECTRIC COMPANY,

Manufacturers and Sole Agents, 45 BROADWAY, N. Y.

RAPIDITY.

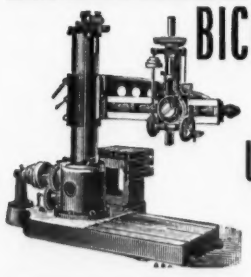


ONE OF OUR MACHINES, using four tools, turns the diameter, squares down both sides and bores twenty blank gears, twenty-three inches in diameter, 4½ in. face, 3⅜ in. bore, per day of ten hours.

SIMPLE TOOLS.
ACCURATE WORK.

The Lodge & Shipley M. T. Co., Cincinnati, O.

BICKFORD DRILL AND TOOL CO.



3 PIKE STREET, CINCINNATI, OHIO.

BUILDERS OF

UPRIGHT, RADIAL, HALF AND FULL UNIVERSAL RADIAL DRILLS.

BORING AND TURNING MILLS.

STEEL CASTINGS

FROM 1 TO 40,000 POUNDS WEIGHT.

Of Open Hearth, Chester or Bessemer Steel.

True to Pattern. Sound. Solid.

GEARING OF ALL KINDS, CRANK SHAFTS, KNUCKLES FOR CAR COUPLERS.

Cross Heads, Rockers, Piston-Heads, etc., for Locomotives. Steel Castings of Every Description.

CHESTER STEEL CASTINGS CO.,

Works, Chester, Pa. Office, 407 Library St., Philadelphia, Pa

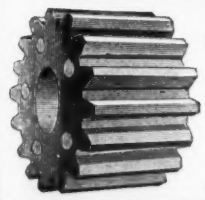
---

STRANGE, BUT TRUE!!

THE NEW PROCESS RAW HIDE GEARS

ASTONISH THE

MACHINERY WORLD.



They **Outwear any Metal.**

They require **No Lubricant.**

They are **Noiseless and Clean.**

NEW PROCESS RAW HIDE CO.,

PATENTEES AND SOLE MANUFACTURERS,

SYRACUSE, N. Y., U. S. A.

"Grand Prix," PARIS. Highest Awards, CHICAGO.

J. A. FAY & CO.,

Offices, FRONT & JOHN STS., Cincinnati, O., U.S.A.

Builders of **WOOD-WORKING MACHINERY** FOR ANY PURPOSE.

WE HAVE THE FINEST CATALOGUES EVER ISSUED.

SOMETHING FOR YOU

TO EXAMINE!

OUR NEW TOOL-BLOCKS

And Accelerated Speed Machines.

HAVE YOU ONE OF OUR CIRCULARS?

A Postal is Sufficient.

HURLBUT-ROGERS MACHINE CO.,

SOUTH SUDBURY, MASS.

EVERY MACHINIST SHOULD HAVE A COPY OF

OUR CATALOGUE.

It is a 704 page cloth bound book. A copy will be sent, express paid, to any one sending $1.00, and the money paid for book will be refunded with first order amounting to $10.00 or over.

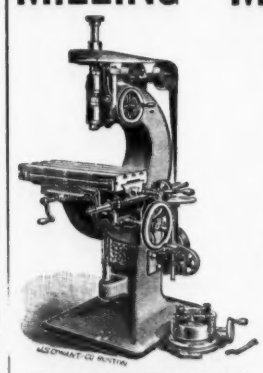
MONTGOMERY & CO.,

105 FULTON STREET, NEW YORK CITY.

JOHN BECKER MANUFACTURING CO.,

MANUFACTURERS OF

VERTICAL MILLING MACHINES,



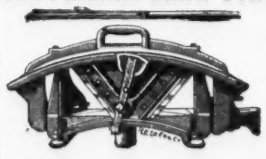
THE BECKER VERTICAL MILLER, No. 3.

TOOLS AND MACHINERY.

BRASS FOUNDERS

Water St., Fitchburg, Mass.

THE PERKINS DRAW STROKE TRIMMER,



An Indispensable Tool for all Bench Woodworkers. Latest and Best Design. Infringers Prosecuted. Trial, not orders, solicited.

PERKINS & CO.,

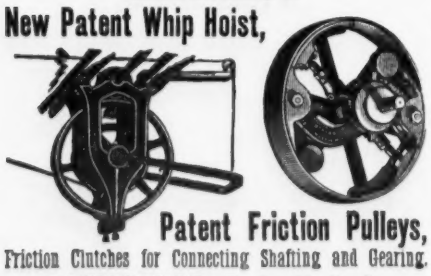
Grand Rapids, Mich.

STOCKS, NEAVE & CO., Manchester, England.

VOLNEY W. MASON & CO.,

MANUFACTURERS OF

New Patent Whip Hoist,



Patent Friction Pulleys,

Friction Clutches for Connecting Shafting and Gearing.

PROVIDENCE, R. I., U. S. A.

Paragon Drawing Instruments, Extra and Best Quality; German Drawing Instruments, Paragon, Duplex, Universal, Anvil Drawing, Helios, Blue Process Papers, Scales, Triangles, T-Squares &c., &c. Catalogue on application. At Columbian Exposition: Liberal Arts Building, Section E. M. 103.

MARKING MACHINE,

For rolling trade-marks on flat or round Iron or Steel surfaces.

Used by Cutlery, Pistol, Twist Drill, Wrench, and many other mfrs.

200 in use.

Read up.

Catalogue "B" free.

DWIGHT SLATE MACHINE CO.,

HARTFORD, CONN.

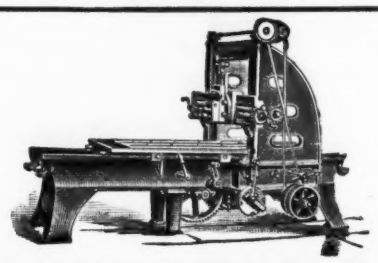
MORSE TWIST DRILL AND MACHINE COMPANY,

Manufacturers of Morse Patent Straight-Lip Increase Twist Drills. New Bedford, MASS.

Solid and Shell Reamers, Beach's Patent Self-Centering Chuck, Bit Stock Drills.
DRILL GRINDING MACHINES, MILLING CUTTERS AND SPECIAL TOOLS TO ORDER.

F. E. REED & CO.,

Worcester, Mass.,
MANUFACTURE
ENGINE LATHES
HAND LATHES, FOOT LATHES AND MILLING MACHINES.
Manning, Maxwell & Moore,
Selling Agents, 111 Liberty St., New York.
515 Phenix Building, Chicago.



New Haven Manf'g Co.,

NEW HAVEN, CONN.
IRON-WORKING MACHINERY.

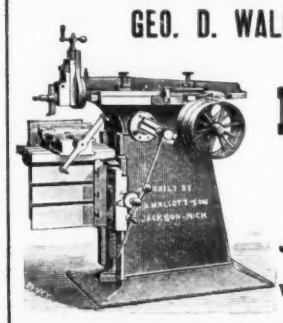
Back Volumes of the
AMERICAN MACHINIST
for 1880, '82, '83, 84, '85, '87, '88, '89, '90, '91 and '92.
A FEW MAY STILL BE HAD.
Address AMERICAN MACHINIST, 203 Broadway, N. Y

The Cincinnati Milling Machine Co.
MILLING MACHINES
Modern Design. New Features. High Class Workmanship
UNIVERSAL CUTTER & REAMER GRINDERS.
Cincinnati, O.
Send for Catalogue

P. BLAISDELL & CO.,

Manufacturers of
Machinists' Tools,
WORCESTER, MASS.

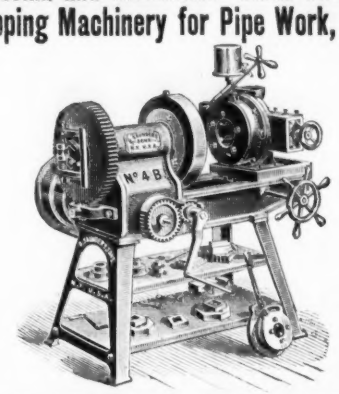
GEO. D. WALCOTT & SON,



Manufacturers of
LATHES AND SHAPERS,
JACKSON, MICH.
Write us for Photo and Prices.

D. SAUNDERS' SONS,

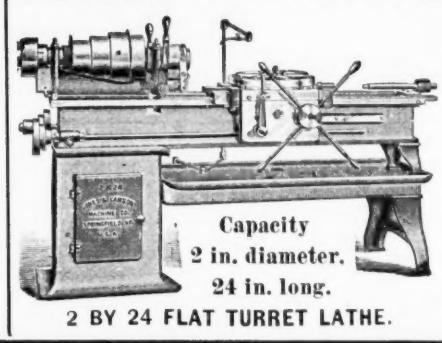
MANUFACTURERS OF
PIPE CUTTING AND THREADING MACHINES,
Steam and Gasfitters' Hand Tools,
Tapping Machinery for Pipe Work, etc.



The No. 4 B Machine for Cutting and Threading Pipe 1 in. to 4 in., by HAND or POWER.
SEND FOR CATALOGUE TO
21 Atherton St., YONKERS, N. Y.

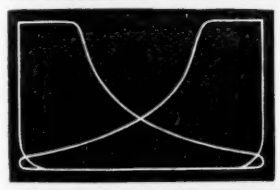
JONES & LAMSON MACHINE CO.,

SPRINGFIELD, VERMONT.



Capacity
2 in. diameter.
24 in. long.
2 BY 24 FLAT TURRET LATHE.

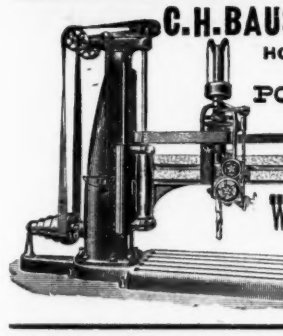
SOLE BUILDERS OF THE
FLAT TURRET LATHE.
ALSO BUILDERS OF OTHER
TURRET MACHINERY.
PUBLISHERS OF
"RAPID LATHE WORK,"
BY NEW METHOD.
(Hartness System.)
SEND FOR CATALOG.



MAKE YOURSELF A
MECHANICAL ENGINEER OR DRAUGHTSMAN;
or qualify to take charge of, or to superintend the manufacture of Machinery, by devoting your idle hours to **Home Study**, by the method of

THE CORRESPONDENCE SCHOOL OF MECHANICS, SCRANTON, PA.

The course embraces instruction in Arithmetic, Algebra, Geometry, Trigonometry, Elementary Mechanics, Hydromechanics, Pneumatics, Heat, Mechanical Drawing, Steam and Steam Engines, Strength of Materials, Applied Mechanics, Boilers, Machine Design, Electricity, Etc. To begin, Students need only know how to read and write. **Moderate Charges. Diplomas Awarded. Send for Free Circular Giving full Particulars.**



C. H. BAUSH & SONS,

HOLYOKE, MASS.
Manufacturers of
POST, SUSPENDED AND Wall Radial Drills
From the smallest to the largest.

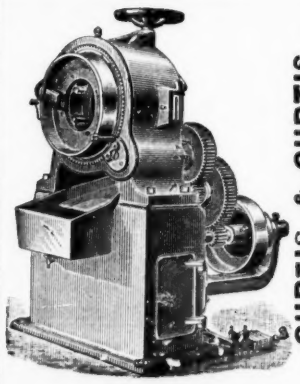
IF YOU HAVE ANY SMALL ARTICLES

in Brass or Iron that you want manufactured in quantities, write to THE JONES BROS. ELECTRIC CO., 28-30-32 West Court St., Cincinnati, O.

BARKER'S IMPROVED CENTER GRINDING MACHINE.

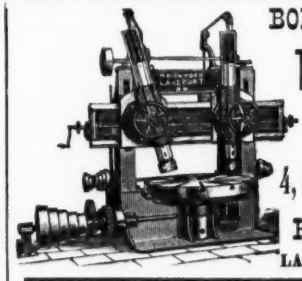
NO GAUGES. NO BELT.
Every Machine Guaranteed.
MANUFACTURED BY
WM. BARKER & CO., Cincinnati, Ohio.
SEND FOR CIRCULAR

PATENT UNIVERSAL
SCREW-CUTTING
CENTRE, DEPTH, ANGLE, AND TWIST DRILL GAGE
J. WYKE & CO. E. Boston, Mass
MFR'S FINE MACHINISTS TOOLS.
SEND FOR LISTS
Chas. CHURCHILL & Co., LTD. AGTS.
21 CROSS ST. FINSBURY, LONDON ENG.



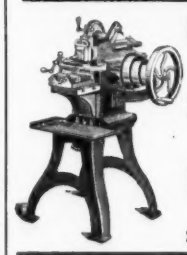
CURTIS & CURTIS,

66 CARDEN ST., BRIDGEPORT, CONN.
Pipe Cutting and Threading Machinery,
FOR HAND OR POWER,
RATCHET DRILLS, RATCHET DIE STOCKS AND MALLEABLE IRON PIPE VISES



BORING AND TURNING MILLS,

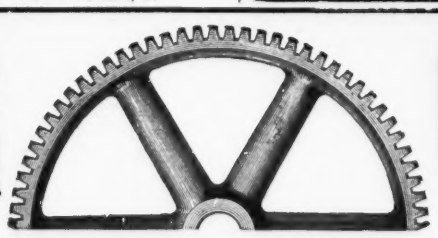
4, 5, & 6 ft. Swing
H. Bickford,
LAKEPORT, N. H.



BOYNTON & PLUMMER,

WORCESTER, MASS.
Manufacturers of
Shaping Machines,
Drilling Machines,
Bolt Cutting Machines.
CHAS. CHURCHILL & CO., Lt'd,
21 Cross St., Finsbury, London.

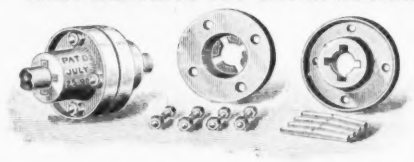
GEARS CUTTING



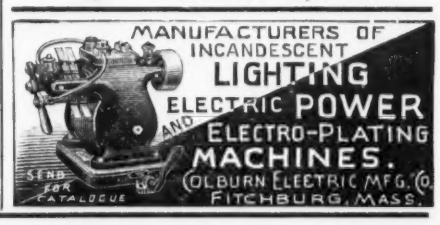
LELAND, FAULCONER & NORTON CO. Detroit, Mich.

Specify Nicholson's Compression Shaft

COUPLINGS, AND GET SOMETHING THAT WILL GIVE YOU SATISFACTION.



No Keys or Keyseats—Satisfaction Guaranteed.
W. H. NICHOLSON & CO., Wilkes Barre, Pa.



SMALL CRANKS AND ENGINE PARTS MADE.

W. D. FORBES & CO.,
HOBOKEN,
N. J.
1300 HUDSON STREET.

MILLING CUTTERS,
FINE TOOLS,
SPECIAL MACHINES,
HARDENED ARBORS.

HAMILTON MACHINE TOOL CO.,

N. E. Cor. Water & Market Sts.,
Hamilton, Ohio, U. S. A.
MODERN DRILL PRESSES
16", 22", 26", 32" and 36"
Back Geared and Power Feed
A SPECIALTY.
CORRESPONDENCE SOLICITED

THE ERIE KEY-SEATING MACHINE.

MANUFACTURED BY
THE BURTON MACHINE CO.,
302 Peach St.,
ERIE, PA.
U. S. A.

Send for Circular.

The cut represents our Stationary and Portable Key-Seating Machine which fully meets all the requirements of a machine shop. They are furnished with one, two or three Arbors as desired, to cut any width of key-seat up to 2 1-2 inches wide.

1 15-16 inches Arbor works in all bores from 1 15-16 inches to 3 inches diameter, and cuts seats 12 inches long.

2 7-16 Inches Arbor works in all bores from 2 7-16 inches to 6 inches diameter, and cuts seats 16 inches long.

4 7-16 inches Arbor works in all bores from 4 7-16 inches to 14 inches diameter, and cuts seats 26 inches long.

With an attachment for the purpose seats can be cut in holes as small as 1 inch diameter, by one passage of the cutter.

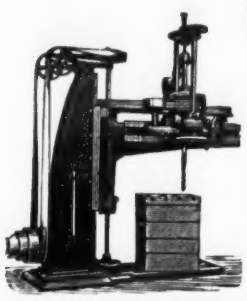
If the work is heavy and too large to be placed on machine it can be detached from stand and used as portable machine.

IF YOU BUILD MACHINERY
THE WOODRUFF SYSTEM OF KEYING
WILL SAVE YOU
From 50 to 75 per cent.
On the Cost of your Keying.
SEND FOR CIRCULAR.
THE WOODRUFF MFG. CO.,
HARTFORD, CONN.

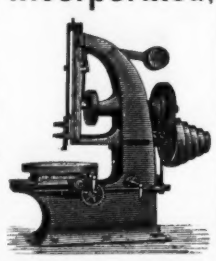
BARNES' UPRIGHT DRILLS

Complete line, ranging from our New Friction Disk Drill, for light work, to 42-inch Back Geared Self Feed Drill.

Send for Catalogue and Prices.
W. F. & JOHN BARNES CO.,
1995 Ruby St., Rockford, Ill.
ENGLISH AGENTS,
CHAS. CHURCHILL & CO., LTD.,
21 CROSS ST., FINSBURY. LONDON, E.C., ENG.

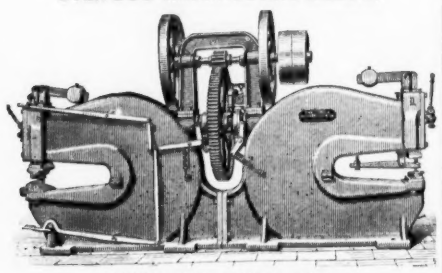


WM. SELLERS & CO., Incorporated,
PHILADELPHIA, PA.
MANUFACTURERS OF
MACHINE TOOLS,
TRAVELING CRANES AND SWING CRANES,
Operated by Electricity, Shafts or Independent Engines.
Turn Tables, Testing Machines, Shafting, Pulleys, Hangers, Couplings, Etc.
INJECTORS FOR ALL CLASSES OF BOILERS.



THE HILLES & JONES CO.,
WILMINGTON, DELAWARE.
Manufacturers of
MACHINE TOOLS
Patent Plate Bending Rolls, all Sizes.
FOR
Boiler Makers, Bridge Builders, Ship Builders, Railroad Shops, Locomotive and Car Builders, Etc., Etc.

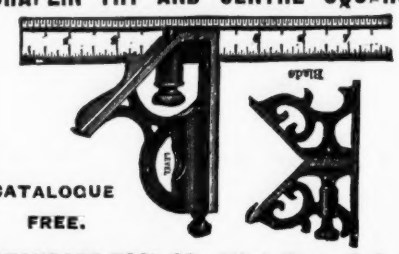
THE LONG & ALLSTATTER CO.,
HAMILTON, OHIO, U. S. A.
OVER 300 VARIETIES AND SIZES OF



DOUBLE PUNCH AND SHEARS.

PUNCHES AND SHEARS
WELDING MACHINES
AND DROP HAMMERS.

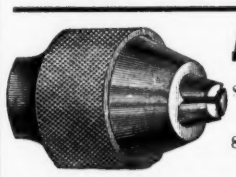
CHAPLIN TRY AND CENTRE SQUARE.



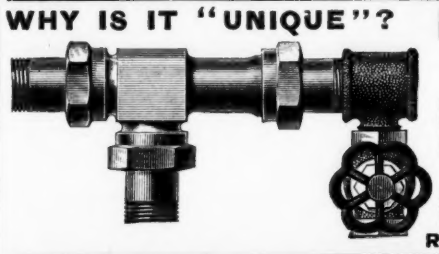
CATALOGUE FREE.

STANDARD TOOL CO., Athol, Mass., U. S. A.
Manufacturers of MACHINISTS' FINE TOOLS.

W. C. YOUNG MFG. CO., WORCESTER MASS.
Foot Lathes, Engine Lathes,
SHEARS AND PUNCHES.



Almond Drill Chuck
Sold at all Machinists' Supply Stores.
T. R. ALMOND,
83 & 85 Washington St.,
BROOKLYN, N. Y.



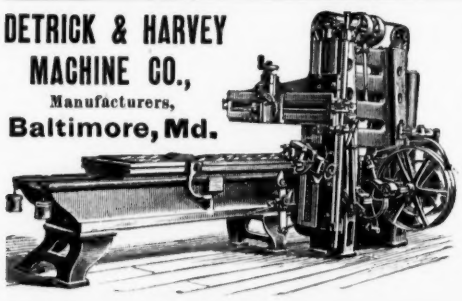
WHY IS IT "UNIQUE"?
BECAUSE IT COMBINES SO MANY GOOD POINTS.
It requires no change for varying pressures of steam, can be placed in any position, is simple in construction, conveniently come at for cleaning, and all valves or other fittings required are such as can be had of any dealer.
Do you want to know more about Rue's "Unique" Single Tube Injector?
If so, send for Catalogue describing this and many other styles, and containing also a great deal of information about injectors of use to every engineer or mechanic.
Rue Mfg. Co., 118 N. 9th St., Phila., Pa.

THE DAVIDSON STEAM PUMPS AND PUMPING ENGINES.

WARRANTED THE **BEST MADE** FOR ALL SITUATIONS.
Manufactured by
M. T. DAVIDSON.
PRINCIPAL OFFICE AND WORKS, 43-53 Keap St., Brooklyn, N. Y.
BRANCH OFFICES: 77 LIBERTY STREET, NEW YORK. 51 OLIVER STREET, BOSTON.

AUTO MATIC
PENBERTHY
INJECTOR
PENBERTHY INJECTOR CO. MFRS., DETROIT, MICH.

DETRICK & HARVEY MACHINE CO.,
Manufacturers,
Baltimore, Md.



OPEN SIDE PLANERS.
Ready for Immediate and Prompt Delivery.
Size C (30" x 30") to plane 6 feet long.
Size C (30" x 30") to plane 8 feet long with extra side head.
Size C (30" x 30") to plane 12 feet long with extra side head.
Size D (36" x 36") to plane 10 feet long with extra side head.
Size D (36" x 36") to plane 12 feet long with extra side head
Size F (48" x 48") to plane 14 feet long with extra side head.
Size F (48" x 48") to plane 16 feet long with extra side head.

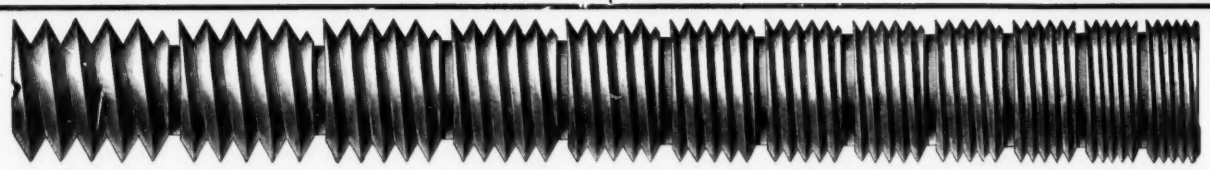
THE VERNON COUNTING REGISTER.

Positive Motion, Steel Gearing, Brass Wheels.
Absolutely Accurate at High Speed.
For Counting Strokes of Engines, Pumps, Speed of Shafting and Automatic Machines, Registering Fares in Turnstiles, etc., etc.
THE DAVIDS MACHINE WORKS,
MANUFACTURERS AND SOLE AGENTS.
OFFICES: 129 WORTH ST., NEW YORK.

ENGINE CASTINGS
⅛ to 2 H.P. Upright, Horizontal and Marine. Illustrated Booklet free on receipt of stamp. Gas Engine and Dynamo Castings. Small Boilers. Experimental work for inventors.
A. L. WEED & CO.,
106 LIBERTY STREET, NEW YORK.

ROBERT POOLE & SON CO.
ENGINEERS & MACHINISTS.
TRANSMISSION MACHINERY
MACHINE MOULDED GEARING
SPECIAL FACILITIES FOR THE
HEAVIEST CLASS OF WORK
BALTIMORE, MD.

All GENUINE INGOTS & MANUFACTURES BEAR OUR REG. TRADE MARKS.
"Phosphor-Bronze"
PHOSPHOR-BRONZE
INGOTS, CASTINGS, WIRE, SHEET &c.
THE PHOSPHOR BRONZE SMELTING CO. LIMITED
512 ARCH ST. PHILADELPHIA PA. U.S.A.
ORIGINAL MANUFACTURERS OF PHOSPHOR-BRONZE IN THE UNITED STATES AND SOLE MAKERS OF "ELEPHANT BRAND" PHOSPHOR-BRONZE.



The above Cut shows 12 Threads from 6 to 20 per inch, cut in

THE NORTON LATHE

They were ALL cut in this Lathe WITHOUT changing gears.
The Lathe was NOT STOPPED during the whole operation.
The Carriage being reversed in the Apron the operator DID NOT touch the Counter Shaft Lever during the whole operation.
The Lathe has 12 FEEDS from 30 to 100 per inch without change of gears.
TWO changes of gear on screw and stud will give 24 ADDITIONAL Feeds and allow 24 DIFFERENT additional threads to be cut.
WE CLAIM it is the MOST CONVENIENT Lathe in use.
WE CLAIM that MORE WORK can be done on it than on ANY OTHER Lathe Made.
This tells OUR part of the story. We shall be pleased to hear from YOU.

THE HENDEY MACHINE COMPANY, TORRINGTON, CONN.

CHAS. CHURCHILL, & CO., Ltd., Agents, 21 Cross Street, Finsbury, London, England.

THE BUCKEYE ENGINE CO., SALEM, OHIO,

have received awards at the World's Fair as follows:

One Medal and Diploma and two Special Diplomas on Simple Engines,

MEDIUM AND HIGH SPEED,

TANDEM COMPOUND AND CROSS COMPOUND CONDENSING AND TRIPLE EXPANSION FOUR CYLINDER CONDENSING ENGINE.

ALBANY STEAM TRAP CO., ALBANY, N. Y.

RETURN STEAM TRAPS, SPECIAL **BOILER FEED PUMPS** AND PUMP GOVERNORS.

AUTOMATIC **STEAM PUMPS** AND GOVERNOR COMBINED FOR PUMPING HOT CONDENSED WATER.

Renewable Seat and Disc VALVES.

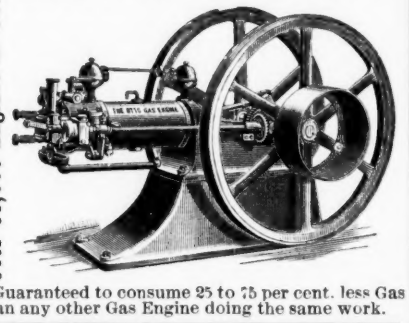
"OTTO" GAS ENGINE WORKS.

SCHLEICHER, SCHUMM & CO.,

33d and Walnut Sts., PHILADELPHIA.

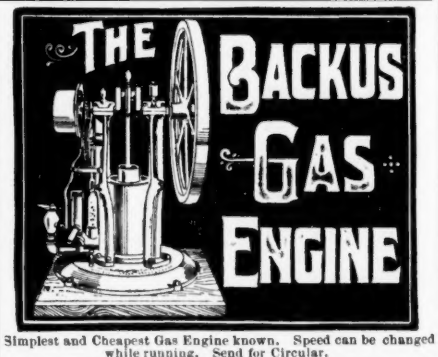
Branch Office, 245 Lake St., CHICAGO. New York Agency, 18 Vesey St., N. Y.

Over 35,000 Engines in Use



Guaranteed to consume 25 to 75 per cent. less Gas than any other Gas Engine doing the same work.

THE BACKUS GAS ENGINE



Simplest and Cheapest Gas Engine known. Speed can be changed while running. Send for Circular.

BACKUS WATER MOTOR CO., Newark, N. J.

Also Mfrs. VENTILATING FANS.

WEBER GAS & GASOLINE ENGINE.

Simplest and most economical engines on earth.

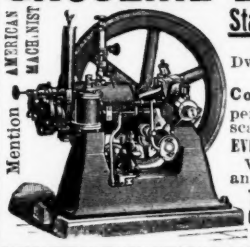
Fully Guaranteed.

A boy starts it, requires only a few minutes' attention a day. Guaranteed cost of running 1 cent per hour per H. P. Write for catalogue. Address Drawer 930.

WEBER GAS AND GASOLINE ENGINE CO.
Kansas City, Mo.

GASOLINE ENGINES.

Stationary & Portable



ALL SIZES.

Dwarfs in size and Giants in Strength.

Costs only 10 cents a Day per H. P. to run them, & scarcely any attention.

EVERY ENGINE GUARANTEED

Write for particulars and testimonials.

THE VANDUZEN GAS & GASOLINE ENGINE CO.
CINCINNATI, O.

Mention AMERICAN MACHINIST

STEAM. CONOVER CONDENSERS. BELT.

BELT AND STEAM DRIVEN.

Compound Condensing Corliss Engine on Independent Condenser.

HANDSOME CATALOGUE FREE.

THE CONOVER MFG. CO.,

39 & 41 CORTLANDT STREET, N. Y.

STEAM WHISTLES

A HOWLING SUCCESS! IS LUNKEN'S MOCKING-BIRD STEAM WHISTLE.

A novel and practical variable sound Steam Whistle for Traction Engines, Locomotives, Steamboats, Factory and Mill use, etc. Attached like any ordinary whistle. The bell is provided with a piston, which is pulled downward by a chain running between pulleys, and when not in use, is always at the top, being drawn upward by means of a spring. To change the sound, pull the chain.

For sale by Leading Dealers throughout the United States. Send for catalogue of Valves, Steam Cocks, Whistles, Lubricators, Oil and Grease Cups, etc., of interest to steam users. Mention AMERICAN MACHINIST.

THE LUNKENHEIMER COMPANY,

SUCCESSOR TO THE LUNKENHEIMER BRASS MFG. CO., CINCINNATI, OHIO, U. S. A.

CHAS. A. STRELINGER & CO.,

Tools, Supplies and Machinery,

DETROIT, MICH.

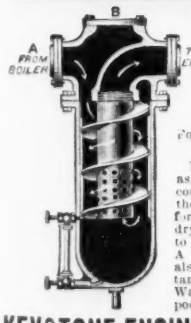
A MARVEL OF POWER SIMPLICITY & LOW COST

ALWAYS READY, NO BOILER, NO FIRE, NO ENGINEER, NO LICENSE, NO DANGER. STATIONARY, MARINE AND PORTABLE ENGINES FOR BOATS, PUMPS, FACTORIES ETC. SMALL SIZES A SPECIALTY.

SAFETY VAPOR ENGINE CO.
15 MURRAY ST. NEW YORK.

SEND FOR CATALOGUE

DRY STEAM.



Simpson's Centrifugal Steam Separator.

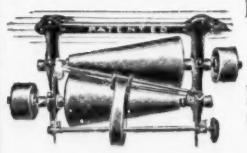
For Supplying Clean and Dry Steam to Engines, Dry Houses, etc.

Place Separator as close to engine as possible, the steam taking a spiral course between the threads causes the water to be thrown by centrifugal force against the outer walls, while the dry steam goes through the small holes to center of pipe. Steam can enter at A or B, as convenience may require; also used in conveying steam long distances, for Steam Hammers, Dry Houses, Water Gas Generators, and for all purposes where Dry Steam is necessary.

KEYSTONE ENGINE & MACHINE WORKS.

Fifth and Buttonwood Streets, Philadelphia.

EVANS FRICTION CONE CO.



HANGING AND STANDING **CONES,**

MADE IN ALL SIZES.

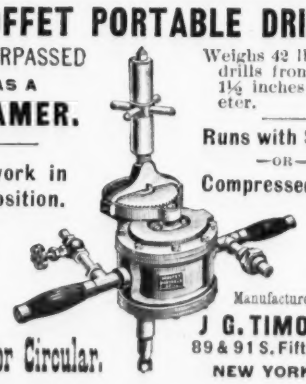
Thousands in use transmitting from 1 to 50 H. P. For information address,

No. 85 WATER STREET, BOSTON, MASS.

MOFFET PORTABLE DRILL.

UNSURPASSED AS A **REAMER.**

Will work in any position.



Weighs 42 lbs. and drills from ⅜ to 1¼ inches diameter.

Runs with Steam —OR— Compressed Air.

Send for Circular.

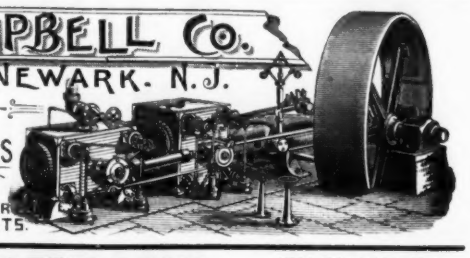
Manufactured by J. G. TIMOLAT,
89 & 91 S. Fifth Ave.,
NEW YORK.

THE WATTS, CAMPBELL CO.

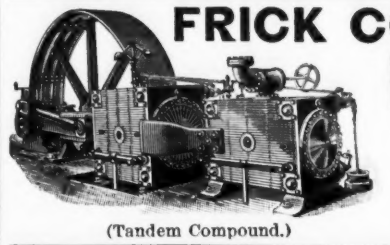
MANUFACTURERS OF IMPROVED CORLISS STEAM ENGINES IN FULL VARIETY.

CONTRACTS TAKEN FOR COMPLETE POWER PLANTS.

NEWARK, N. J.



FRICK COMPANY, WAYNESBORO, PA.



(Tandem Compound.)

ECLIPSE CORLISS ENGINES,

40 TO 2,000 H. P., ALL STYLES.

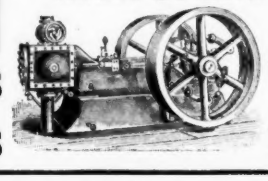
Send for Illustrated Catalogue.

ALSO BUILDERS OF

Electric High Speed Engines and Ice-Making and Refrigerating Machinery.

WESTON AUTOMATIC HIGH SPEED ENGINES

HIGH PRESSURE BOILERS AND COMPLETE POWER PLANTS

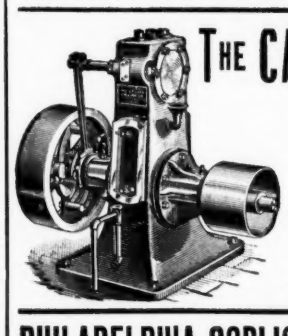


WESTON ENGINE CO.,
PAINTED POST, N. Y.

REPRESENTATIVES

JULIAN SCHOLL & CO., 126 Liberty St., N. Y.
GEO. D. HOFFMAN, 82 Lake St., Chicago.
H. M. SCIPLE & CO., 3d & Arch Sts., Phila., Pa.

THE CASE AUTOMATIC HIGH SPEED ENGINE



SIMPLICITY, COMPACTNESS.

Automatic Lubrication, Perfect Regulation,

The Latest Development in High Speed Engine Building.

BUILT IN SIZES FROM 2½ to 25 H. P.

Manufactured by THE J. T. CASE ENGINE CO.,

New Britain, Conn., WM. S. HINE, Gen'l Sales Mgr.

PIERCE & MILLER ENGINEERING CO., Selling Agents for New York and Export, 42 Cortlandt Street, N. Y.

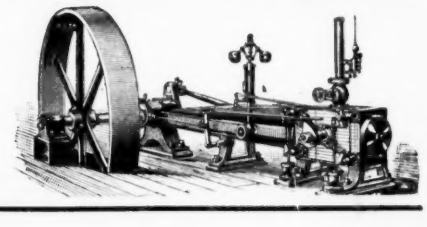
PHILADELPHIA CORLISS ENGINES,

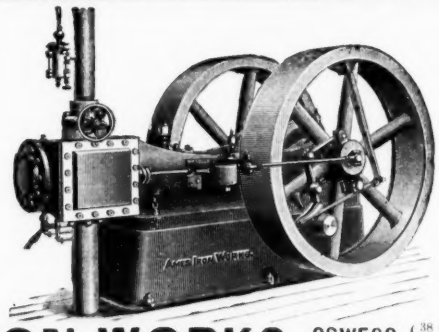
Simple, Compound and Triple-Expansion,

ALL SIZES.

Philadelphia Engineering Works, Ltd.

Mifflin St., East of Front, PHILADELPHIA, PA.





AMES IRON WORKS, OSWEGO, N. Y.

38 Cortlandt Street, New York City.
18 South Canal Street, Chicago, Ill.
50 Oliver Street, Boston, Mass.
518 Arch Street, Philadelphia, Pa.

THE LANE & BODLEY CO.

CINCINNATI, OHIO.

SHAFTING, HANGERS, PULLEYS.

(Turned) (Strong, self-oiling) (Good proportions)

SPECIAL STANDS FOR HEAVY SHAFTING.

CORLISS ENGINES,

Belt Elevators, Saw Mills, Etc.

COMPLETE POWER EQUIPMENT.

AS AN EXPERT machinist, I am free to own that I think the machinery I make is the very best of its kind.

I spare no pains or cost to make it so. My customers tell me I succeed.

Let me send you a catalogue.

P. PRYIBIL, 498 to 510 West 41st Street, New York.

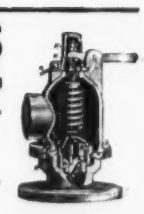
Machinery Catalogues. { A. WOODWORKING MACHINERY. B. MACH'Y FOR BRASS, IVORY, HORN, ETC. C. SHAFTING, PULLEYS, HANGERS, ETC.

LONERGAN'S SPECIALTIES

Oil Cups for all Purposes. Sight Feed Lubricators. Pop Safety Valves, Check Valves, Water Relief Valves, etc. "Clipper" Injectors, and other Steam Appliances.

J. E. LONERGAN & CO., 211 Race St., Phila., Pa.

CATALOGUE FREE ON APPLICATION.



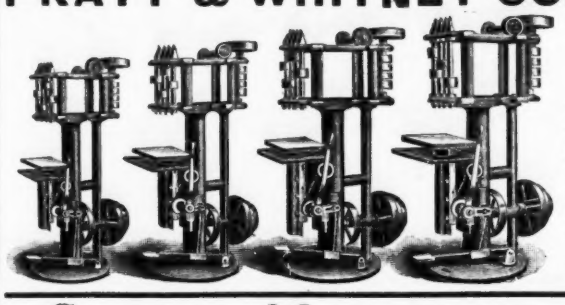
BROWN & SHARPE MFC. CO., Providence, R. I.

No. 3 UNIVERSAL GRINDING MACHINE, 20 in. x 72 in.

For grinding internal or external, hard or soft, cylindrical or conical surfaces, swings 20" in diameter and takes 72" in length. Net Weight 7 260 pounds.

ENGLAND—BUCK & HICKMAN, 280 Whitechapel Road, London, E.
GERMANY—G. DIECHMANN, Ansbacherstr. 5 Berlin, W. 62.
FRANCE—FENWICK FRERES & CO., 21 Rue Martel, Paris.
FRANCE—F. G. KREUTZBERGER, 140 Rue de Neuilly Puteaux (Seine).
CHICAGO, ILL.—FRED. A. RICH, 23 South Canal St

PRATT & WHITNEY CO., HARTFORD, CONN., U. S. A.



MANUFACTURE

GANG DRILLS

of improved design, with two, three, four and six spindles in four sizes. The spindles are made of tool steel, have steel boxes hardened and ground, with provision for adjustment for wear. Tables are counterbalanced. Ask for the

"MACHINISTS" CATALOGUE.

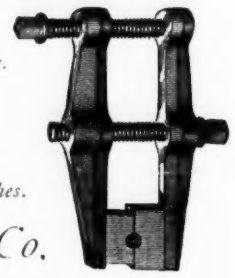
C AND MACHINISTS' CLAMPS.

C Clamps, in 5 Sizes, with Openings

1¼, 2¼, 3¼, 4½, 6½ *inches.*

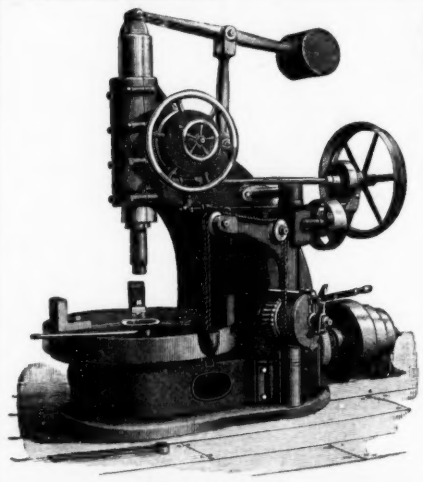
Machinists' Clamps, in 4 Sizes, with Openings

1¼, 2¼, 3¼, 4¼ *inches.*



The Billings & Spencer Co.

Hartford, Conn., U. S. A.



CAR WHEEL BORER.

MACHINE TOOLS.

Complete Equipments.

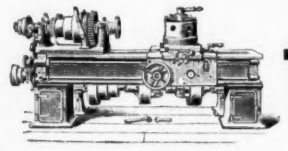
RAILROAD, CAR, LOCOMOTIVE AND GENERAL MACHINE SHOPS.

BRANCH HOUSES:
NEW YORK, CHICAGO, BOSTON, PHILADELPHIA, PITTSBURGH.

THE NILES TOOL WORKS CO.,
HAMILTON, OHIO.

Correspondence Solicited.

WARNER & SWASEY,
CLEVELAND, OHIO.
MANUFACTURERS OF



TURRET ENGINE LATHES.

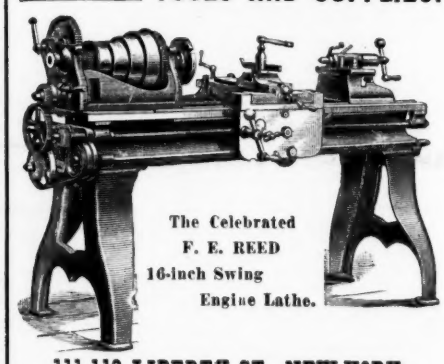
IRON AND BRASS WORKING MACHINERY.
SEND FOR ILLUSTRATED CATALOGUE.

GEO. W. FIFIELD,

Manufacturer of ENGINE LATHES from 17 to 50 in. swing. Cuts, Photographs and Prices furnished on application.
Lowell, Mass., U. S. A.

MANNING, MAXWELL & MOORE,

Manufacturers and Dealers in all kinds of RAILWAY and MACHINISTS' **TOOLS AND SUPPLIES.**



The Celebrated F. E. REED 16-inch Swing Engine Lathe.

111-113 LIBERTY ST., NEW YORK,

We carry the largest line of Tools and Supplies in the City.

To Those Interested In, or Using Valves:

We have recently made improvements in the manufacture of **JENKINS BROS.' VALVES**, having increased the number of bo ts, thickness of flanges, etc. We shall manufacture **ONE GRADE OF VALVE ONLY**, suitable for high or low pressure steam. The Jenkins Discs used in these valves are suitable for high or low pressure. We guarantee all valves stamped with Trade Mark.

JENKINS BROS.
New York, Boston, Philadelphia, Chicago.

BEMENT, MILES & CO.,
PHILADELPHIA, PA.
BUILDERS OF

METAL-WORKING MACHINE TOOLS

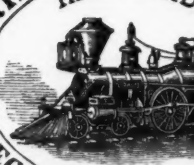
FOR

RAILROAD SHOPS, LOCOMOTIVE AND CAR BUILDERS, MACHINE SHOPS, ROLLING MILLS, STEAM FORGES, SHIP YARDS, BOILER SHOPS, BRIDGE WORKS, ETC., ETC.

NEW YORK OFFICE, EQUITABLE BUILDING.
GEORGE PLACE, Agent.

PRICES REDUCED
ON
20 in. W. & L. DRILLS.
LARGE STOCK, QUICK DELIVERY.
Write for Catalogue and Prices.
W. P. DAVIS,
Rochester, N. Y.

HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

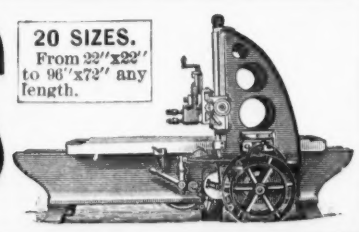


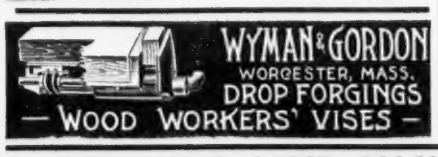
HARTFORD, CONN.

J. M. ALLEN, PRESIDENT.
WM. B. FRANKLIN, VICE-PRESIDENT.
F. B. ALLEN, SECOND VICE-PRESIDENT
J. B. PIERCE, SECRETARY & TREASURER

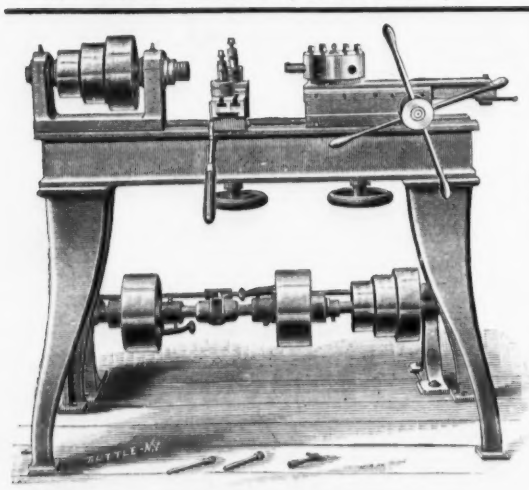
SPUR- AND SPIRAL-GEARED
("SELLERS' MOTION")
PLANERS
MADE BY
The G. A. GRAY CO.,
477-483 SYCAMORE ST., CINCINNATI, O.

20 SIZES.
From 22"x22" to 96"x72" any length.





WYMAN & GORDON
WORCESTER, MASS.
DROP FORGINGS
— WOOD WORKERS' VISES —



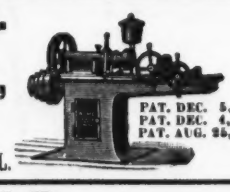
TURRET LATHES
In 4 Sizes and 60 Varieties,
SCREW - MACHINES
In 5 Sizes and 68 Varieties,
Of our own Manufacture.
The LARGEST STOCK of
Metal-Working Machinery
IN NEW YORK.

Write for Complete List, Catalogue and Prices.

NO. 2 TURRET LATHE.

THE GARVIN MACHINE CO.,
LAIGHT AND CANAL STS., NEW YORK.

THE ACME MACHINERY CO.
CLEVELAND, OHIO.
Manufacturers of
ACME BOLT & RIVET HEADERS,
Acme Single & Double Automatic BOLT CUTTERS.
Cutting from 1-8 in. to 6 in. diameter.
Also SEPARATE HEADS and DIES.
FIRST PREMIUM CINCINNATI CENTENNIAL.



PAT. DEC. 5, 1882.
PAT. DEC. 4, 1883.
PAT. AUG. 26, 1884

FOR SALE CHEAP.

We intend to take out several of our old style lathes from 14" to 18" swing, 6 to 10 ft. beds to be replaced by

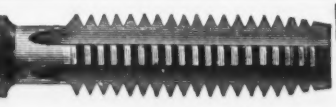
IMPROVED HENDEY-NORTON LATHES

and offer them at moderate prices. They are in first-class condition, some having been used less than a year.

THE HENDEY MACHINE CO., TORRINGTON, CONN.

See our Advertisement on page 18.

J.M. CARPENTER
PAWTUCKET, R.I.



Manufacturer —of— **TAPS & DIES**